

# CITY OF RENTON PUBLIC WORKS

## MAINTENANCE DIVISION

### CONFINED SPACE PROGRAM

## TABLE OF CONTENTS

I.	OVERVIEW.....	3
II.	ROLES & RESPONSIBILITIES.....	5
III.	CONTROL OF ENTRY.....	7
IV.	EQUIPMENT PROVIDED TO EMPLOYEES AT NO COST.....	8
V.	GENERAL CONFINED SPACE ENTRY PROCEDURES.....	9
VI.	EVALUATE AND CONTROL HAZARDS FOR SAFE ENTRY.....	11
VII.	MONITORING OF CONFINED SPACES.....	12
VIII.	SAFE ENTRY PROCEDURES INTO CONFINED SPACES.....	13
IX.	ENTRY RESCUE AND NON-ENTRY RESCUE PROCEDURES.....	16
X.	ALTERNATE ENTRY PROCEDURES.....	17
XI.	CLASSIFY A CONFINED SPACE AS A NON-PERMIT SPACE.....	19
XII.	TRAINING.....	20
XIII.	OUR RESPONSIBILITIES FOR CONTRACTORS ENTERING CITY OF RENTON CONFINED SPACES.....	22
XIV.	OUR RESPONSIBILITIES WITH HOST EMPLOYERS (CITY OF RENTON ENTERING ANOTHER EMPLOYER’S CONFINED SPACES).....	23
XV.	RESCUE AND EMERGENCY SERVICES.....	23
XVI.	REQUIRED PROGRAM REVIEW.....	24
XVII.	DEFINITIONS.....	25
	APPENDIX A: PUBLIC WORKS CONFINED REVIEW CHECKLIST.....	29
	APPENDIX B: CONFINED SPACE SOP/PERMIT.....	30
	APPENDIX C: HOT WORK PERMIT.....	44
	APPENDIX D: MANUFACTURER’S OPERATOR MANUAL.....	45

**CITY OF RENTON PUBLIC WORKS  
MAINTENANCE DIVISION  
(Water, Wastewater, Surface Water, and Equipment Rental Sections)  
CONFINED SPACE ENTRY PROGRAM**

**I. OVERVIEW**

This entry program:

- Describes our procedures for worker safety and health in confined spaces and is written for our Public Works Department as staff in this department may enter confined spaces.
- Describes how we manage permit required confined spaces.
- Describes required training for our employees and describes our responsibility for contractors entering City confined spaces.

City of Renton Public Works confined spaces include:

- a. Reservoirs
- b. Manholes/Catch Basins/non-potable water pipelines Dry wells
- c. Wet Wells/Lift Stations
- d. Dry Wells/Lift Stations
- e. Chemical storage vaults
- f. Water Storage Tanks/Tanks
- g. Vaults

For locations or a listing of Public Works Confined Spaces please refer to the GIS Mapping, and EAM Maintenance Program available on the Rentonnet (Intranet). Specific entry procedures for each type of space are provided in the Standard Operating Procedures (SOPs) attached to this plan.

A **confined space** is a space that is ALL of the following:

- Large enough and arranged so an employee could fully enter the space and work.
- Has limited or restricted entry or exit. Examples of spaces with limited or restricted entry are tanks, vessels, silos, storage bins, hoppers, vaults, and pits.
- Not primarily designed for human occupancy.

A **permit-required or permit space** is a confined space that has one or more of the following characteristics capable of causing death or serious physical harm:

- Contains or has a potential to contain a hazardous atmosphere.
- Contains or has a potential to contain a material with the potential for engulfing someone who enters the space.
- Has an internal configuration that could allow someone entering to be trapped or asphyxiated by inwardly converging walls or by a floor, which slopes downward and tapers to a smaller cross-section.

- Contains any physical hazard. This includes any recognized health or safety hazards including, electrical shock, or moving parts.
- Contains any other recognized safety or health hazard that could either:
  - Impair the ability to self-rescue or
  - Result in a situation that presents an immediate danger to life or health.

A **non-permit space** is a space that does **not** contain actual hazards or potential hazards capable of causing death or serious physical harm.

The City of Renton will treat all confined spaces as permit-required spaces until they have been evaluated **and** are documented to be non-permit or alternate entry. **City Of Renton (COR) Permit-required confined spaces will only be entered into by Public Works employees when non-entry rescue can be used. Public Works employees at the City of Renton do not perform entry rescue. The following criteria must be met to be considered a non-entry rescue space:**

- a. The opening is at least 18 inches in diameter.
- b. The size and stature of the entrant along with his/her PPE and any tool-belt can clear the opening.
- c. There is a horizontal and stable surface surrounding the opening to support a tripod, davit or mobile davit and the attendant.
- d. The weight of the entrant and his/her equipment does not exceed the rating and purpose of the retrieval winch.
- e. The length of lifeline cable is adequate for the entrant to remain attached while working in the space.
- f. The retrieval system (harness and lifeline) can be used without the entrant or harness getting caught on anything while working, or in the event he/she needs to be hoisted out of the space with the retrieval system.
- g. Once inside the space the entrant will not travel over baffles or beyond protruding pipes or obstacles in the direction of travel where the harness or lifeline could become caught.

**Note:** All Public Works employees at the City Shops (except administrative staff and transportation) are trained in confined space entry.

Prior to daily work in Public Works confined spaces, the Department supervision will meet with each employee involved for a pre-entry briefing. The briefing will consist of a review of every confined space to be entered on that day. The supervisor will also review the known hazards of each space, the City entry procedures, required equipment, planned rescue, non-entry rescue procedures, and any other information necessary for safe entry. This will be a time for staff to ask questions, make suggestions or voice concerns. The "Public Works Confined Space Review Checklist" will be used for this briefing (see Appendix A). Every permit filled out for the day will be attached to the Public Works Confined Space Review Checklist and kept on file for 24 months. Reviews of these confined space entry records will be performed every year by the Administrator or his/her designee.

Employee exposure monitoring, if done for any confined space entry, will be kept in employee files for 30 years. Completed permits and checklists that show an actual atmospheric hazard an employee entered or worked in will be kept for 30 years as employee exposure records.

When opening a manhole lid to assess or observe, City employees will not break the plane of the space with a body part. Once the plane of the space has been broken or is intended to be broken a permit is required. All confined spaces are considered to be permit required until they have been evaluated **and** are documented to be non-permit or alternate entry.

## **II. ROLES & RESPONSIBILITIES**

Primary responsibility for oversight of the Public Works Department Confined Space Entry Program is the Administrator or his/her designee.

### **Confined Space worker definitions**

#### **1. Attendant**

An individual stationed outside one or more permit-required confined spaces to monitor the entrants and to perform non-entry rescue.

#### **2. Entrant**

An employee who is authorized by the employer to enter a permit-required confined space. Entrant will wear monitoring device and continuously monitor calling out readings every 15 to 30 minutes to log.

#### **3. Entry supervisor**

The person (such as the employer, crew leader, or crew chief) responsible for:

- a) Determining if acceptable entry conditions are present at a permit-required confined space where entry is planned;
- b) Seeing that the permit is properly completed
- b) Authorizing entry and overseeing entry operations; and
- c) Terminating entry as required.

The following table shows which City Public Works positions are responsible for the tasks outlined:

**Table 1**

Position	Task
<b>Department Supervision</b>	Evaluate our work locations and determine: <ul style="list-style-type: none"> <li>• The presence of a Confined Space at the worksite.</li> <li>• Permit-required Confined Space exists at the worksite.</li> </ul>
<b>Entry Supervisor/ Department Supervision</b>	Evaluate the confined space to determine what hazards are present, if any.
<b>Entry Supervisor/ Department Supervision</b>	Verify entry permit is properly completed and sign it.
<b>Entry Supervisor/ Department Supervision</b>	Meet with employees for pre-entry briefing.  Evaluate hazards and determine the appropriate entry procedure for the space.  <b>Note:</b> <ul style="list-style-type: none"> <li>• Until evaluated and documented otherwise, all Confined Spaces <b>shall</b> be considered permit-required spaces.</li> <li>• Alternate entry procedure</li> <li>• Inform exposed or potentially-exposed employees of the existence and hazards of confined space using the methods described below under “Control Entry.”</li> <li>• Make sure that all equipment needed for safe entry into a confined space is available and in proper working order.</li> </ul>
<b>Entry Supervisor</b>	Provide employees entering confined spaces, or their designated representative, an opportunity to observe pre-entry testing and any subsequent testing. <ul style="list-style-type: none"> <li>• All test results will be provided to the entrants or their representatives upon request.</li> </ul> The space will be re-evaluated if entrants or their representatives believe that the space was inadequately tested.  Re-evaluate the space when the use, configuration, or hazards of a confined space change.
<b>Attendant</b>	Individual stationed outside the permit required confined space to monitor the entrant and perform non-entry rescue

Position	Task
<b>Entrant</b>	Employee authorized to enter permit required confined space and will wear the monitoring device to continuously monitor for hazardous atmospheres calling out readings every 15 to 30 minutes to log.
<b>Department Manager/Director</b>	Conduct a review using cancelled permits to identify and correct and deficiencies in our program or spaces.

### III. CONTROL OF ENTRY

1. Every employee who enters a confined space or encounters a fall hazard of 10 feet or more shall ensure that all provisions of this procedure and the fall protection work plan (see Policy 700-26) have been satisfied prior to entry and/or commencement of work. WAC 296-155-24505 requires a fall protection work plan if the fall hazard is 10 feet or more. The requirements for fall protection and a fall protection work plan are triggered at 10 feet.

WAC 296-809-50016 requires that a mechanical retrieval device be at the site if the entry is 5 feet or deeper.

WAC 296-24-75003 and 75005 (walking and working surface code) requires protection from a working surface with a fall hazard of 4 feet or more if anyone is close to an open man hole, vault, etc. or standing on a walking surface near the opening. The City requires an attendant be standing and monitoring the location to keep the person from falling into the hole. Alternatively, guardrails can be used to mitigate the fall hazard.

When going up or down a fixed ladder the fall protection trigger height increases to 24 feet before fall protection is needed. If the space is 24 feet or greater, the City requires a harness be used at all times.

2. We use the following method(s) to inform employees about the existence and hazards of confined space, and to prevent unauthorized entry:
  - Pre-entry briefing with supervisor;
  - Signs posted at each permit space reading "Danger- Confined Space- Do Not Enter" or similar language;
  - Barriers;
  - Never leaving the confined space unattended when entry is occurring;
  - Listing hazards for confined space on the SOPs.

3. The Attendant will take the following actions when unauthorized persons approach or enter a space:
  - Warn unauthorized persons to stay away from the space.
  - Tell the unauthorized persons to exit immediately if they have entered the space.
  - Inform Entrants and the Entry Supervisor that unauthorized persons have entered the space.
4. If the work area contains, or is, a permit area, a placard stating “Danger Permit-Required Confined Space – Follow Entry Procedure before Entering” will be located conspicuously outside the area.
5. Confined Space Supervisor/manager will prevent unauthorized employees and the public from entering permit-required confined spaces. Supervisor/manager will also inform affected employees about the existence, location, and danger of any permit-required confined space by posting danger signs.

#### IV. EQUIPMENT PROVIDED TO EMPLOYEES AT NO COST

The City will provide the equipment in Table 2 below, when needed, and will:

1. Make sure that employees use provided equipment properly; and
2. Maintain the provided equipment at no cost to employees. Equipment is kept in the Shops warehouse and the water parts store room. Air monitoring equipment is maintained by the Manufacturer, Service Vendor, and the Lift Station Technician and Maintenance Worker III. Operation Manuals for the Air Monitoring Equipment are included in Appendix D and C. The manufacturers’ representative will train City of Renton staff on the use and maintenance of all confined space monitoring equipment.

**Table 2**

Type of Equipment	Use
Testing and monitoring equipment	Evaluating permit-required conditions
Ventilating equipment	Creating and maintaining acceptable atmospheric entry conditions
Communication equipment	Providing effective communication between the Attendant and the Entrants and to initiate rescue when required (radios or walkie talkies as needed)
Lighting equipment	Providing adequate lighting for employees to work safely and to exit the space quickly in an emergency
Personal protective equipment (PPE)	Protecting employees from hazards of the space or work performed
Non-entry rescue and emergency equipment, such as tripods, davits and harnesses, except for equipment provided by an entry rescue service.	Providing safe and effective non-entry rescue

Barriers or shields	Protecting employees from physical hazards outside of the space, such as objects that might fall into the space
Any other equipment/PPE	Safe entry into and non-entry rescue from permit-required confined spaces

**Equipment Malfunction** - Anyone noting a malfunction of any gas detector, sampling device, ventilation equipment, fall protection equipment, or any other device required for safe entry and/or safe fall protection shall immediately remove the equipment from service, write a report, place a completed “RED REPAIR TAG” on the equipment, noting the piece as deficient, and turn the item in to the Supervisor/Manager for repair.

The Entry Supervisor is responsible for safe entry and for the issuance of all oxygen and gas detectors and other sampling and/or safety equipment. The entry permit shall be completed prior to entering or commencement of work. The manager, supervisor, and lead worker shall know the proper operation of all sampling and/or safety equipment. The person responsible for confined space and/or fall protection work plan safety who is listed on the entry permit shall know the proper operation of all equipment to be used and shall be responsible for ensuring the employee is trained in the operation of the equipment.

## V. GENERAL CONFINED SPACE ENTRY PROCEDURES

City of Renton Public Works entry procedures for confined spaces include the initial assignment by the Supervisor, Manager, or Lead. Once assigned, the crew has a pre-entry briefing with Supervisor. During the pre-entry briefing they discuss every aspect of entry, SOP/Permit and Pre-Entry Checklist. All Confined Space entry is typically pre-scheduled, if during routine maintenance they discover a new Confined Space, the crew will determine if entry is necessary and it will be assigned a date of entry and a pre-briefing will occur prior to entry. The information regarding the new space will be catalogued along with attributes of the space. An engineer will assign a space number and a category. The entry check list will be presented to the Supervisor/Manager/Lead to be used for scheduling of the entry at a future date. If there is an emergency or urgent need to enter a confined space, the lead, supervisor or manager will meet with the crew at the entry site and discuss the hazards involved before entering.

Prior to work that requires entry into Public Works confined spaces, the Department supervision will meet with each employee involved for a pre-entry briefing. The briefing will consist of a review of every confined space to be entered on that day. The supervisor will also review the known hazards of each space, the City entry procedures, required equipment, planned rescue, non-entry rescue procedures, and any other information necessary for safe entry. A review of the testing conditions for any confined spaces that may have layered atmospheres will be addressed and the appropriate method of testing per the operator’s manuals. This will be a time for staff to ask questions, make suggestions or voice concerns. The details obtained in the Public Works Confined Space Review (or pre-entry) Checklist” will be used for this pre-entry briefing.

- A. In the pre-entry meeting, identify and evaluate potential hazards from:
  - 1. The confined space; and
  - 2. The work to be performed.
- B. Complete an entry permit before entry is authorized, documenting that you have completed the means, procedures and practices necessary for work and safe, non-entry rescue.
- C. Make sure that Entrants or their representatives have an opportunity to observe any monitoring, testing, or actions to eliminate or control hazards performed to complete the permit.
- D. Identify the Entry Supervisor.
- E. Make sure the Entry Supervisor signs the entry permit, authorizing entry, before the space is entered.
- F. Make the completed permit available to entrants or their authorized representatives at the time of entry by posting the completed permit at the entry location; or by involving each staff person present at the entry site in the completion of the permit and the review of the completed permit
- G. Make sure the duration of the permit does not exceed the time required to complete the assigned task or job identified on the permit.
- H. Entry Supervisors will make a visual check of crews making entries to assure correct procedures are being followed and safety precautions are being taken and any problems encountered during an entry operation will be noted on the permit. This information will be used by management to make appropriate revisions to the program, entry operations, means, systems, procedures and practices as needed. The permit will document how it was determined that the confined space contained no permit-required hazards.

All entrants and attendants will have a company-issued cell phone or a two-way radio for communication when verbal and line of sight communication is not possible. However where possible entrants and attendants will use visual contact and verbal communication which is more effective and practical.

## VI. EVALUATE AND CONTROL HAZARDS FOR SAFE ENTRY

- A. The Entry Supervisor will evaluate atmospheric hazards for safe entry into confined spaces with a multi-gas meter. They will test for atmospheric hazards in this order: oxygen content, flammable gasses and vapors, and potential toxic air contaminants.
- B. The following limits are used for safe entry:
  - a. **Oxygen:** between 19.5% and 23.5%
  - b. **Combustible Gases:** less than 10% of the lower explosive limit (LEL)
  - c. **Toxic Gases and Vapors:** Hydrogen Sulfide (H<sub>2</sub>S) less than 5ppm
  - d. **Carbon Monoxide (CO):** less than 20ppm
  - e. If combustible dust that reduces visibility to five feet or less is observed, entry will not continue.
- C. The entry supervisor will provide each entrant or their authorized representative the opportunity to observe pre-entry testing and subsequent testing.
- D. The entry supervisor will ensure that pumps and lines are blocked or disconnected; (when unable to block or disconnect, we will perform permit entry):
  - a. All pumps and lines which may reasonably cause contaminants to flow into the confined space will be disconnected, blinded, and locked out/tagged out, or effectively isolated by other means to prevent development of dangerous air contamination or engulfment.
  - b. Not all lateral lines to sewers or storm drains require blocking. However, where experience or knowledge of use indicates a reasonable potential for contamination of air or engulfment into an occupied sewer, then all affected lateral lines are to be blocked.
- E. Surveillance: The entry supervisor and/or attendants will survey the surrounding area prior to entry to avoid hazards such as drifting vapors from the tanks, piping, or sewers.

## VII. MONITORING OF CONFINED SPACES

- A. The Entry Supervisor will re-evaluate the space in the presence of any entrant, or his/her authorized representative, who requests this to be done because they have reason to believe that the evaluation of that space may not have been adequate.
- B. Upon request, immediately provide each entrant or his/her authorized representative, with the results of any testing required by this rule.
- C. The Attendant will evaluate space conditions, then hand off monitoring device to the Entrant. The Entrant will continuously monitor conditions in areas where working calling out readings every 15 to 30 minutes to log. Always monitor, even if you can isolate!!
- D. How to test in layered atmospheres/deep spaces

- **Duration of Testing**

For each test required on the permit, you must allow enough time for the air from the space to be drawn into the equipment and for the sensor (or other detection device) to react to the chemical if it is present. This is considered the "minimum response time" and it will be noted by the manufacturer in the operator's manual. Be aware that you will need to add time to this "minimum response time" if you have attached hosing or a probe extension to the inlet. The additional time is needed to allow the air from the different depths of the space to be pulled into the equipment inlet.

- **Testing Conditions in Spaces that May Have Layered Atmospheres**

For permit spaces that are deep or have areas leading away from the entry point, the atmosphere may be layered or may be different in remote areas. For these spaces, testing must be done in the area surrounding the worker, which is considered four (4) feet in the direction of travel and to each side. If a sample probe is used to do the testing, then the worker must move slowly enough so that testing is completed, keeping the equipment "response time" in mind, before he/she moves into the new area."

**Evaluate space conditions during entry as follows:**

<b>Evaluating Space Conditions</b>	
<b>You must:</b>	<b>In order to:</b>
The Entry Supervisor must test conditions before entry	Determine that acceptable entry conditions exist before entry is authorized by the Entry Supervisor
The Attendant must test or evaluate space condition.	Determine that acceptable entry conditions are being maintained during entry operations
The Entry Supervisor must evaluate entry operations	Make sure Entrants of more than one employer working at the same time in or around a permit-required confined space don't endanger each other

**VIII. SAFE ENTRY PROCEDURES INTO CONFINED SPACES**

The Entry Supervisor responsible for the safety of entry, as named on the entry permit, shall evaluate, plan, and implement the procedures necessary to safeguard the personnel assigned to the job. The planning conducted at the pre-entry briefing will ensure the availability of required safety equipment, its serviceability and a thorough analysis of potential hazards from unplanned events or actions which could alter the plan. An entry permit shall be completed for each separate job, each day. In applying these procedures, consideration shall be given to specific conditions that exist at the time. The pre-entry briefing helps to anticipate the potential hazards during permit entry and identify controls that will limit the possibility of employee exposure should the conditions of the permit space change significantly. Worst-case scenario will always be planned for.

**A. Safety Equipment-** For the purpose of this procedure, at least the following will be available:

1. Oxygen and gas detectors and other sampling devices as needed.
2. Blowers and auxiliary equipment as designated for entering confined spaces.
3. A safety harness and life line for the entrant.
4. All confined spaces over 4 feet deep shall be entered via safely installed confined space steps or a separate ladder of appropriate length.
5. Ear protection from noise, protective clothing for heat, electrical or corrosive hazards, and respirators shall be worn, as needed.
6. Appropriate traffic control signs-devices and guards to protect the confined space and workers shall be utilized.

## B. Entering Confined Spaces:

1. Before entering, warning devices, guards, etc., will be installed by the crew to provide adequate protections to workers and the public. The Entry Supervisor and/or Attendant will visually check around the outside of the confined space first, and then carefully remove cover before testing.
2. To remove the cover, lift the lid just enough to insert the testing device to get an accurate test. This should be done in such a way as to avoid sparks. The crew will never use an open flame to thaw ice around a cover. Initial testing of a confined space atmosphere will be done through holes in the confined space cover where possible. The potentially toxic atmosphere will be tested for oxygen and flammability then hydrogen sulfide, or carbon monoxide depending on the space.
  - a. Never strike a seated cover with a steel or iron tool, and exercise care to reduce the potential for sparks. If needed, a hardened bronze cold chisel or some other non-sparking implement should be used.
  - b. If the initial test checks within limits listed in Section VI, the entrant or attendant will remove the confined space cover and prior to entry, test again! If all tests are within limits listed above, the confined space may be entered. Upon initial entry, the attendant will take additional tests with the appropriate meter. Test generally at all areas and levels of the confined space. All monitoring results will be documented on the permit.
3. Even if all tests are within allowable limits, confined spaces that are 15 feet deep or greater shall be purged initially with a power blower with a fresh supply of air for at least 5 changes of air, but never less than 5 minutes. Ventilation will be continuous.
4. The atmosphere shall be monitored continuously. The Entry Supervisor will evaluate space prior to entry, and then hand off monitor to the Entrant. Entrant will monitor continuously and call out readings every 15 to 30 minutes to log. All work shall stop and the confined space evacuated if atmospheric testing fails. Re-entry sampling shall be conducted after ventilation has been provided. Sampling should be conducted anytime a confined space is reopened or for crew changes.
5. If atmospheric conditions are measured and found to be outside acceptable operating conditions, evacuate the space and perform the following procedures:
  - For oxygen deficiency, evacuate the space and ventilate for 5 air changes and test again. All staff is trained in ventilation and air changes. Do not enter an atmosphere that tests below 19.5% oxygen (or greater than 23.5%) by volume. If you cannot get a safe reading, close the confined space and contact your supervisor. The minimum ventilation time shall be 5 minutes.
  - If flammable gases are detected above 10% of the lower explosive limit, evacuate the space. Close the confined space and advise the supervisor.

### C. Pumps and lines:

- All pumps and lines which may reasonably cause contaminants to flow into the sewer are disconnected, blinded, and locked out/tagged out, or effectively isolated by other means to prevent development of dangerous air contamination or engulfment by PRCS crew.
- Not all lateral lines to sewers or storm drains require blocking. However, where experience or knowledge of use indicates a reasonable potential for contamination of air or engulfment into an occupied sewer, then all affected lateral lines are to be blocked.

- D. Protective clothing and gloves shall be worn when entering a confined space, wet well or sewer. In spaces which do or could contain corrosive chemicals which are toxic through contact, special equipment to prevent skin or eye contact shall be worn. Emergency wash stations are installed at facilities that have corrosive hazards, or portable eyewash kits are included in vehicle first aid kits.
- E. All workers shall wear a hard hat when working in a confined space.
- F. All crew members working at a confined space entry shall carry a current first aid card recognized by the Department of Labor and Industries.
- G. Lighting - The National Electrical Code requires special lighting equipment shall be Class 1, Division 1 rated for work in confined spaces which contain a flammable atmosphere. The City shall provide the intrinsically safe equipment and no other equipment shall be used. All portable lights and tools shall be "explosion proof" when working in potentially flammable atmospheres.
- H. Supervisors shall ensure that workers in confined spaces are not exposed to chemical, physical and biological agents. The best assurance is that we evaluate the confined space and do not enter if these agents are present and cannot be eliminated.
- I. No matches, lighters or any other items capable of producing a spark or flame (other than approved tools) are allowed in a confined space. Radio, flashlights, lanterns, lighted smoking materials shall not be used within 10 feet of an open confined space.
- J. Entry Supervisors shall ensure that adequate procedures are implemented to prevent foreign objects, tools, rocks, dirt, water, etc., from entering a confined space.
- K. Hot work permits shall be required prior to doing hot work in a confined space. Hot work means any work which requires the intentional use of an ignition source of any type which could ignite flammable gases or vapors, i.e. a cutting torch, welding apparatus, etc. See the City Hot Work policy and utilize a hot work permit if this work is to be performed in a confined space.

- L. If a confined space is determined to be an entry rescue confined space –stop work, do not enter under any circumstances close the vault and call a supervisor. If hazardous atmospheres cannot be eliminated the space is determined an entry rescue permit-required confined space. Refer to IX. ENTRY RESCUE AND NON-ENTRY RESCUE PROCEDURES.
- M. All Entrants and Attendants will have a company issued cell phone or a two-way radio available for communication if verbal and visual communication is not practical.

**Never enter until the atmosphere tests safe.**

**Never enter a contaminated or an oxygen-deficient atmosphere.**

**If you are not sure - don't go in.**

**If you smell anything different or feel different - get out now!**

## **IX. ENTRY RESCUE AND NON-ENTRY RESCUE PROCEDURES**

The City of Renton does not perform entry rescue in permit-required confined spaces. The City performs non-entry rescue only. The City will contract out any entry rescue work. The contractor we use for entry rescue PRCS with hazards that can't be mitigated is NRC Environmental Services, or other City-approved contractor.

### **When performing non-entry rescue, the Entry Supervisor and Attendant must**

- Use non-entry retrieval systems or methods to rescue entrants in a permit-required confined space unless this:
  - Would increase the overall risk of injury to entrants.

**or**

  - Wouldn't contribute to the rescue of the entrant.

If either of the above conditions is present, NRC Environmental Services, or other City approved contractor will do the confined space entry and rescue work.

- Make sure each Entrant uses a full-body harness, with a retrieval line attached to the harness at one of the following locations:
  - At the center of the employee's back, near shoulder level.
  - Above the employee's head.
  - At another point which presents a profile small enough for the successful removal of the employee.

- Attach the retrieval line to an approved safe mechanical device or fixed point outside the space, so rescue can begin as soon as necessary. This is typically a tripod or davit.
- Make sure a mechanical device is available to retrieve entrants from vertical spaces more than 5 feet (1.52 m) deep.

#### Vehicle Mounted Davits

1. Vehicle wheels must be securely chocked, with the vehicle transmission in gear or park and the emergency brake on
2. Vehicle keys under control of Entrant.
3. Vehicle steering wheel clearly labeled to not operate the vehicle.
4. Davit and vehicle mount must be designed for non-entry rescue purposes.
5. All approved traffic control procedures must be in place.

## **X. ALTERNATE ENTRY PROCEDURES**

Spaces that have hazardous atmospheres as their only hazard will use alternate entry procedures.

Alternate entry procedures require the use of a City of Renton Confined Space Entry Permit.

Management will make sure, when using alternate entry procedures, that monitoring and inspection data supports the following:

- That the only hazard of the confined space is an actual or potentially hazardous atmosphere.
- That continuous forced air ventilation alone is all that is needed to maintain the confined space for safe entry.
- Make sure all documentation produced is available to each affected employee and their authorized representative.

The City of Renton will do all of the following when using alternate entry procedures:

- A. Reduce unsafe conditions before removing entrance covers. Remove lid carefully (see Section B-2A). Engulfment hazards must be eliminated to be considered alternate entry.
- B. After removing entrance covers, promptly guard the opening with a railing, temporary cover, or other temporary barrier to prevent accidental falls through the opening and protect entrants from objects falling into the space.
- C. Certify that pre-entry measures have been taken (such as safe removal of the cover and having protection needed to gather pre-entry data), with the date, location of the space, and signature of the person certifying.

- D. Make the pre-entry certification available to each entrant before entry.
- E. Before an employee enters the confined space, test the internal atmosphere with a calibrated, direct-reading instrument for all the following, in this order: oxygen content, flammables and toxins.

If gases are found or an oxygen deficiency exists, the following procedures should be implemented:

1. Ventilate continuously until atmosphere is brought to normal limits of 19.5% to 23.5% oxygen, less than 10% of the LEL, less than 20ppm Carbon Monoxide, and less than 5ppm Hydrogen Sulfide. Once you demonstrate atmosphere is at acceptable levels you may enter under alternate entry. The attendant will continue to monitor during entry. Gas and oxygen testing shall be performed **continuously**, no matter how "clean" the confined space seems to be.
2. If ventilation does not eliminate the hazards and at any time the concentrations exceed **10% of the lower explosive limit**, cease operations. Close the confined space and advise the supervisor. You have now determined that a permit and permit-entry procedures are required for entry into this space.

Blowers should be located so there are no unnecessary bends in the hose. One 90-degree bend reduces the blower capacity to 70% of rated capacity. Two bends of 90-degrees reduces capacity to 50% or by half. Blowers shall be located so they will not pick up exhaust gases or fuel vapors (e.g. gasoline, propane, etc.) from vehicles, heaters, furnaces, or the blower engine. The blowers should operate for one minute, to flush out the hose, prior to placing it in the confined space.

3. The entry supervisor or attendant will provide entrants, or their authorized representatives, with an opportunity to observe the pre-entry and periodic testing. Make sure the atmosphere within the space is not hazardous when entrants are present.

Use continuous forced air ventilation, as follows:

- Wait until the forced air ventilation has removed any hazardous atmosphere before allowing entrants into the space.
  - Direct forced air ventilation toward the immediate areas where employees are, or will be, and continue ventilation until all employees have left the space.
  - Provide the air supply from a clean source and make sure it does not increase hazards in the space.
4. Test the atmosphere within the space **continuously** to make sure hazards do not accumulate.
  5. If a hazardous atmosphere is detected during entry, we will do all of the following:
    - Evacuate employees from the space immediately,
    - Evaluate the space to determine how the hazardous atmosphere developed.
    - Implement measures to protect employees from the hazardous atmosphere before continuing the entry operation.
    - Verify the space is safe for entry before continuing the entry operation.

6. The written documentation is available on site to each employee entering the space or to that employee's representative.
7. Safety harnesses shall be worn with any alternate entry into a confined space, unless re-classifying to a non-permit.
8. A parachute or chest type of harness shall be used which will facilitate the emergency removal from the space.
9. All entrants and attendants will have a company issued cell phone or a two-way radio for communication while in a confined space.

## **XI. CLASSIFY A CONFINED SPACE AS A NON-PERMIT SPACE**

As of this writing, the City of Renton treats all confined spaces as permit-required confined spaces. Currently, there are no spaces we classify as non-permit. If in the future it becomes appropriate to classify a space as non-permit, we will document the space conditions and follow the procedures in this section.

A confined space will be classified as a non-permit as long as no hazards exist in or around the space. The permit shall be filled out prior to entry. If a hazard is present, you must follow all requirements of this part that apply, to make sure any space you classify as non-permit does not have the potential to contain serious health or safety hazards. Examples of permit-required confined spaces that may be considered for reclassification as non-permit in the future include storm manholes, tanks, and vaults with blanked pipes, valve and PRV vaults which have been isolated by shutting off valves.

Make sure the confined space meets these conditions to be classified as non-permit confined space:

- A. The confined space does not contain an actual or potential hazardous atmosphere.
- B. The confined space does not contain hazards capable of causing death or serious physical harm. This includes any recognized health or safety hazards including engulfment in solid or liquid material, electrical shock, or moving parts.
- C. If a crewmember must enter to remove hazards, the space must be treated as a permit-required confined space until hazards have been eliminated. If controlling atmospheric hazards through forced air ventilation does not eliminate the hazards it remains a permit-required confined space but will be entered using alternate entry. The supervisor should evaluate the use of lockout-tag out to determine if using it fully eliminates the hazard.

You are allowed to use alternate entry procedures covered in WAC 296-809-600, if you can demonstrate that forced air ventilation alone will control all hazards in the space.

Documentation on the permit that no permit-required hazards exist will include the following:

- The date, location, and signature of the person making the determination.
- How we determined that no permit-required hazards exist.
- Documentation will be available to entrants or their authorized representatives by asking the entry supervisor or posting at the entry to the space.

## **XII. TRAINING**

The City provides training to each employee involved in confined space activities, so they acquire the understanding, knowledge and skills necessary to safely perform their assigned duties, establish proficiency in their duties, and to introduce new or revised procedures as necessary.

Classroom training is provided to Public Works employees. The City uses outside experts such as Argus Pacific, Evergreen Safety, and United Rentals to train our staff. We also use videos from LNI and purchase videos to train on confined space. We have safety meetings monthly and may have a speaker come in or conduct a training ourselves. We try to get a variety of trainers to meet the needs of staff with diverse learning styles.

We will provide confined space training to employees at the following times: When hired upon orientation they will be trained to the City of Renton Confined Space policy, before they are assigned confined space duties, so new employees are aware of our confined spaces. They will receive certification training before they are asked to actually enter a confined space.

- When their assigned duties change.
- When there is a change in a space that creates hazards for which they have not been trained.
- If we have reason to believe that there are deviations from City procedure for entry or employee knowledge or use of procedures is inadequate.
- Annually we conduct an update.

The new employee will receive a copy of our policy and procedure at every annual update. We may also show a video on confined space entry, and supervisors will continually observe confined space entry until trained and certified for entry by confined space consultant. The new hire will not enter a Confined Space until Confined Space certified.

The Supervisor will verify employee proficiency in their assigned duties by observing as they perform their work. Certification is issued by a consultant and will contain each employee's name, the trainer's written or electronic signature or initials, and the dates of training. Certificates are available for inspection by employees or their authorized representatives.

**Supervisors will also determine proficiency by observing employee performance during entries, and during training exercises. Supervisors will also observe confined space entry periodically of the trained staff and conduct surprise visits to observe and mentor or correct if necessary.**

**Following are 6 basic categories of training, based on duties and potential exposure:**

1. City supervisors provide awareness training to all employees potentially exposed to permit spaces, covering the following:
  - a. The location and hazard of each space
  - b. The company program for confined space
  - c. Emphasis on **not** entering the space for any reason.
2. The City provides a consultant for entry and exit training for the following team members:
  - a. Entrants
  - b. Attendants/non-entry rescuers
  - c. Entry Supervisors
3. Training on how to manage entries for entry supervisors is provided by a consultant.
4. Pre-entry procedure training provided by a consultant for all:
  - a. Entrants
  - b. Entry Supervisors
  - c. Attendants/non-entry rescuers
5. A consultant will provide training on evaluating and testing for:
  - a. Entry supervisors
  - b. Staff assigned to test and evaluate the space
6. Retraining for employees when there is any reason to believe they are not proficient at their duties will be provided by the City or consultant as needed.

The City will have annual practice sessions for all employees entering confined spaces. Annual practice sessions will allow each employee the opportunity to enter a space and be observed and perform non-entry rescue practice. Each employee will play the role of entrant, the attendant and the entry supervisor. Training will be provided on each typical representative type of space. Employees will also practice inspection of and troubleshooting rescue equipment. The annual practice session will be documented and kept on file for 5 years.

In accordance with the manufacturer's instructions, rescue equipment dedicated for use in practice sessions will be kept separate from equipment used in actual confined space entry in the field.

The Confined Space Practice Roster will be used for all Practice Session and retained for a period of 5 years.

### **XIII. OUR RESPONSIBILITIES FOR CONTRACTORS ENTERING CITY OF RENTON CONFINED SPACES**

- A. The City of Renton Confined Space Entry Program is available on the Renton City website. The City includes standard language provisions in its capital improvement project contracts and its construction permit conditions requiring each contractor to:
1. Review and be familiar with the City's on-line Confined Space Public Works Entry Program.
  2. Review documented information about the City confined spaces in which entry is intended as listed and described in the City's Attribute and Map Book. This information includes identified hazards for each permit-required confined space.
  3. Each contractor shall have their own confined space entry program. Upon request of the City they will provide a statement confirming they are in compliance with their confined space entry program including requirements for confined space training for employees associated with the project in Renton.
  4. Be responsible for following all confined space requirements established by the provisions in WAC 296-809 and its chapters.
  5. Coordinate entry operations with the City of Renton when employees from the contractor will be working in or near City confined spaces.
  6. Discuss entry operations with the City of Renton including the program followed during confined space entry.
  7. Debrief the City on any hazards confronted or created at the completion of entry operations.
  8. Place signs stating, "Danger, Follow Confined Space Entry Procedure Before Entering" at each confined space to be entered. Never leave the confined space open and unattended.
- B. The contractor's or consultant's point of contact with the City in regard to confined space entry will be the City's assigned construction inspector and/or the City's project manager.

#### **XIV. OUR RESPONSIBILITIES WITH HOST EMPLOYERS (CITY OF RENTON ENTERING ANOTHER EMPLOYER'S CONFINED SPACES)**

Obtain any available information about confined space hazards and entry operations from the host employer.

Our Entry Supervisor will do the following to make sure entry operations are coordinated with host employers:

1. Obtain any information on the hazards of the permit space and information from previous entry operations
2. Determine if other workers will be working in or near the space.
3. Coordinate entry operations with other workers.
4. Inform the host employer of the confined space program that we follow.
5. Hold a debriefing conference at the completion of the entry operation, or during the entry operation if needed, to inform the host employer of any hazards confronted or created during work in the space.
6. Inform the employer of any hazards you confronted or created while in their space

#### **XV. RESCUE AND EMERGENCY SERVICES**

The City of Renton does not provide entry rescue services, as we do not enter permit required confined spaces unless non-entry rescue procedures apply. We contract out for those services with qualified consultants or contractors. These qualified consultants or contractors provide their own rescue operations. One of the City's contractors for entry-rescue and emergency services is:

##### **NRC Environmental Services**

**26328 79th Ave. S.**

**Kent, WA 98032**

**253.872.8988**

**Emg Resp.1.800.33.SPILL**

The City has a list of other contractors they may use as well.

- For emergency situations in a confined space, the entry teams will work together to assess and determine if 911 services will be called. If emergency action is required, entry personnel will call 911 from their cell phone. Immediately after calling 911 entry personnel will contact supervisor. All staff is certified in CPR. All trucks are equipped with a two-way radio for dispatch. If immediate hazards to injured personnel are present, workers at the site will implement emergency procedures without entering the sewer. When it is practical, the full-body harness is used to suspend a person upright and a hoisting device or similar apparatus is available for lifting workers out of the sewer. If at any time the use of a hoisting device or full-body harness and attached lifeline will endanger the worker, their use will be discontinued

We train employees on the specific procedures for summoning the rescue and emergency services. When needed, we call 911. City staff performing entry-rescue is cause for discipline up to and including termination.

### Procedures for Safely Removing Workers from Sewers (Non-Entry rescue)

If	Then
There is any questionable action or non-movement by the worker inside	<ul style="list-style-type: none"> <li>- Perform a verbal check.</li> <li>- Immediately remove the worker from the sewer if there is no response –use non-entry removal</li> </ul>
The worker is disabled due to falling or impact	<ul style="list-style-type: none"> <li>- Do not remove the worker from the sewer unless there is immediate danger to the worker's life.</li> <li>- Notify local rescue personnel immediately.</li> <li>- <b>Make sure the standby worker doesn't enter the sewer in this case.</b> <ul style="list-style-type: none"> <li>▪ Only trained rescue personnel (wearing self-contained breathing apparatus-SCBA) will enter to perform a rescue.</li> </ul> </li> <li>- Make sure all workers entering the space use a full-body harness with attached lifeline with the free end of the line secured outside the entry opening.</li> <li>- Make sure the standby worker uses the lifeline to attempt to rescue a disabled worker without entering the space and summons rescue services based on their assessment of the situation.</li> </ul>

## XVI. REQUIRED PROGRAM REVIEW

At least every 12 months, supervisors will conduct a review using canceled entry permits to identify any deficiencies in our program. We will conduct a review immediately if there is reason to believe that the program does not adequately protect our employees, such as the following situations:

- A. Unauthorized entry of a permit space
- B. Discovery of a hazard not covered by the permit
- C. Detection of a condition prohibited by the permit
- D. An injury or near-miss during entry
- E. Change in the use or configuration of the space

**Or**

- F. Employee complaints of confined space program ineffectiveness.

Corrective measures will be documented by revising the program. Employees will participate in revising the program, and will be trained on any changes. Failure to comply with these procedures is grounds for discipline, up to and including termination.

## XVII. DEFINITIONS

**Acceptable Entry Conditions** - The conditions that must exist in a permit-required confined space to allow safe entry and work

**Attendant** - An individual stationed outside one or more permit-required confined spaces to monitor the entrants.

**Blanking Or Blinding** - The absolute closure of a pipe, line, or duct by fastening a solid plate (such as a spectacle blind or a skillet blind) that completely covers the bore. It is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plate.

**Confined Space** - A space that is **all** of the following:

- Large enough and arranged so an employee could fully enter the space and work.
- Has limited or restricted entry or exit. Examples of spaces with limited or restricted entry are tanks, vessels, silos, storage bins, hoppers, vaults, excavations, and pits.
- Not primarily designed for human occupancy.

**Double Block And Bleed** - The closure of a line, duct, or pipe by closing and locking or tagging 2 in-line valves and by opening and locking or tagging a drain or vent valve in the line between the 2 closed valves.

**Emergency** - Any occurrence, (including any failure of hazard control or monitoring equipment) or event, internal or external to the permit-required confined space that could endanger authorized entrants.

**Engulfment** - The surrounding capture of a person by a liquid or finely divided (flow able) solid substance that can be inhaled to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

**Enter (Entry)** - The action by which a person passes through an opening into a permit-required confined space and includes work activities in that space. Entry is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

**Note:** If the opening is large enough for the worker to fully enter the space, a permit is required even for partial body entry. Permits aren't required for partial body entry where the opening isn't large enough for full entry, although other rules such as chapter 296-803 WAC lockout-tag out, and chapter 296-841 WAC, Airborne contaminants will apply.

**Entrant** - An employee who is authorized by the employer to enter a permit-required confined space.

**Entry Permit (Permit)/SOP** - The written or printed document that is provided by you to allow and control entry into a permit-required confined space and that contains the information required in WAC 296-809-500, Permit Entry Procedures.

**Entry Supervisor** - The person (such as the employer, crew leader, or crew chief) responsible for:

- Determining if acceptable entry conditions are present at a permit-required confined space where entry is planned;
  - Authorizing entry and overseeing entry operations
- and**
- Terminating entry as required.

**Hazardous Atmosphere** - An atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from a permit-required confined space), injury, or acute illness caused by one or more of the following:

- a. **Oxygen:** less than 19.5% or greater than 23.5%
- b. **Combustible Gases:** greater than 10% of the lower explosive limit (LEL)
- c. **Toxic Gases and Vapors:** Hydrogen Sulfide (H<sub>2</sub>S) greater than 5ppm
- e. **Carbon Monoxide (CO):** greater than 20ppm. **If combustible dust** that reduces visibility to five feet or less is observed, entry will not continue.
  - Flammable gas, vapor, or mist in excess of 10% of its lower flammable limit (LFL).
  - Airborne combustible dust at a concentration that meets or exceeds its LFL.

**Note:** This concentration will be approximated as a condition in which the dust obscures vision at a distance of 5 feet (1.52 m) or less.

- Atmospheric oxygen concentration below 19.5% or above 23.5%.
- Atmospheric concentration of any substance which may exceed a permissible exposure limit. For additional information about atmospheric concentration, see chapter 296-62 WAC, Parts F, G, and I, General Occupational Health Standards and chapter 296-841 WAC, Airborne contaminants.

**Note:** An airborne concentration of a substance that isn't capable of causing death, incapacitation, and impairment of ability to self-rescue, injury, or acute illness due to its health effects isn't covered by this definition.

- Any other atmospheric condition that is immediately dangerous to life or health.

**Note:** You can find guidance on establishing acceptable atmospheric conditions for air contaminants, which have no WISHA-determined doses or permissible exposure limits using other sources of information, such as:

- Material safety data sheets required by WAC 296-800-170, Employer Chemical Hazard Communication.
- Published information
- Internal documents.

**Hot Work Permit** - A written authorization to perform operations, for example, riveting, welding, cutting, burning, and heating, that can provide a source of ignition.

**Immediately Dangerous To Life Or Health (IDLH)** - Any of the following conditions:

- An immediate or delayed threat to life
- Anything that would cause irreversible adverse health effects
- Anything that would interfere with an individual's ability to escape unaided from a permit-required confined space.

**Note:** Some materials - hydrogen fluoride gas and cadmium vapor, for example - may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12 to 72 hours after exposure. The victim "feels normal" after recovery from transient effects until collapse. Such materials in hazardous quantities are considered to be "immediately" dangerous to life or health (IDLH).

**Inerting** - The displacement of the atmosphere in a permit-required confined space by a noncombustible gas (such as nitrogen) to such an extent that the resulting atmosphere is noncombustible.

**Note:** This procedure produces an IDLH oxygen-deficient atmosphere.

**Isolation** - The process by which a permit-required confined space is removed from service and completely protected against the release of energy and material into the space by such means as:

- Blanking or blinding
- Misaligning or removing sections of lines, pipes, or ducts
- A double block and bleed system
- Lockout or tag out of all sources of energy

or

- Blocking or disconnecting all mechanical linkages.

**Line Breaking** - The intentional opening of a pipe, line, or duct that is or has been carrying flammable, corrosive, or toxic material, an inert gas, or any fluid at a volume, pressure, or temperature capable of causing injury.

**Non-Permit Confined Space** - A confined space that does **not** contain actual hazards or potential hazards capable of causing death or serious physical harm.

**Oxygen Deficient Atmosphere** - An atmosphere containing less than 19.5% oxygen by volume

**Oxygen Enriched Atmosphere** - An atmosphere containing more than 23.5% oxygen by volume

**Permit-Required Confined Space Or Permit Space** - A confined space that has one or more of the following characteristics capable of causing death or serious physical harm:

- Contains or has a potential to contain a hazardous atmosphere
- Contains a material with the potential for engulfing someone who enters
- Has an internal configuration that could allow someone entering to be trapped or asphyxiated by inwardly converging walls or by a floor, which slopes downward and tapers to a smaller cross section
- Contains any physical hazard. This includes any recognized health or safety hazards including engulfment in solid or liquid material, electrical shock, or moving parts
- Contains any other recognized serious safety or health hazard that could either:
  - Impair the ability to self-rescue
- or**
- Result in a situation that presents an immediate danger to life or health.

**Permit-Required Confined Space Program** - An overall program for:

- Controlling and appropriately protecting employees from permit-required confined space hazards;
- and**
- Regulating employee entry into permit-required confined spaces.

**Prohibited Condition** - Any condition in a permit-required confined space that isn't allowed by the permit during the authorized entry period.

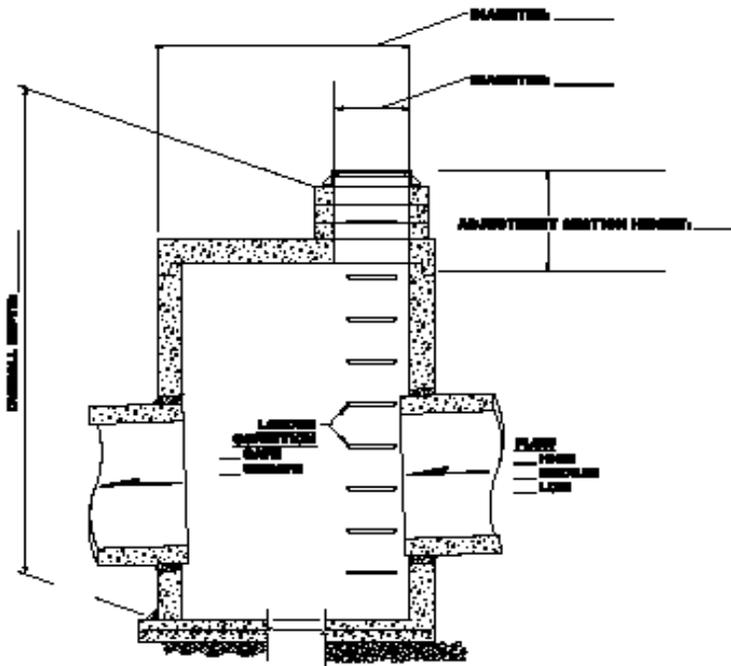
**Rescue Service** - The personnel designated to rescue employees from permit-required confined spaces.

**Retrieval System** - The equipment used for non-entry rescue of persons from permit-required confined spaces, such as a retrieval line, full-body harness or wristlets, and a lifting device or anchor.

**Testing** - The process of identifying and evaluating the hazards that entrants may be exposed to in a permit-required confined space. Testing includes specifying the tests that are to be performed in the permit-required confined space.

**Note:** Testing allows employers to devise and implement adequate controls to protect entrants during entry, and to determine if acceptable entry conditions are present.

## APPENDIX A: PUBLIC WORKS CONFINED REVIEW CHECKLIST

City of Renton		<b>CONFINED SPACE PRE-ENTRY CHECKLIST</b>	
			
GENERAL DATA		TRAFFIC CONSIDERATION	
DATE		NUMBER OF LANES	
ADDRESS		SPEED LIMIT	
CREW		SIGNS NEEDED?	<input type="checkbox"/> YES <input type="checkbox"/> NO
STRUCTURE NUMBER		LANE CLOSURE REQUIRED?	<input type="checkbox"/> YES <input type="checkbox"/> NO
LOCATION	<input type="checkbox"/> RESIDENTIAL AREA <input type="checkbox"/> COMMERCIAL AREA	FLAGGERS NEEDED?	<input type="checkbox"/> YES, _____ FLAGGERS NEEDED <input type="checkbox"/> NO
NOTES:			

## APPENDIX B: CONFINED SPACE SOP/PERMIT

### Confined Space Safe Operating Plan and Permit - Manhole

**Confined Space Classification:** Permit-Required confined space

**Description:** Manhole

**Location:** \_\_\_\_\_

**Routine Maintenance Activities:** Inspection/repair

\*\*\*This SOP/Permit must be submitted and kept for at least one year\*\*\*

**NOTE:** If any deviations or revisions are made to this SOP, you must contact the City of Renton Risk Management Department for approval prior to such revisions.

**1. Confined Space Criteria-Does This Space Have Any of the Following:**

- Limited access/egress: Yes
- Not made for continuous occupancy: Yes
- Large enough to bodily enter: Yes
- Potential to contain a hazardous atmosphere: Yes

**2. Purpose for Entry:** Inspection/repairs

**3. Known Confined Space Hazardous Conditions:** (encountered during entry or generated by the work)

- **Atmospheric:** Evaluated at pre entry.
- **Hazardous Materials Use:** NA
- **Residual Materials:** Evaluated at pre entry
- **Physical Hazards:** falls, cuts
- **Configuration Hazards:** Difficult exit, sharp objects, fall hazards
- **Engulfment hazard:** Sudden unexpected flows.

Note: This SOP was prepared for routine entries only. This SOP does not apply to work activities which may generate hazardous atmospheres. If “hot work” (welding, torch cutting, grinding) or if hazardous materials are used, additional atmospheric hazards may be generated and additional precautions may be required. The City of Renton Risk Management Department and site must be contacted prior to any non-routine entries under these conditions.

**4. Conditioning and Isolating the Space:** (Acceptable Entry Conditions if Applicable)

- Lockout/Tag out energy sources: NA
- Inserting/Purging/Blanking: Vacuum, purge with breathable air
- Wash and flush space: Yes
- Remove all residues: NA
- Barricade access points: Yes
- Atmospheric testing: (Alarm Settings) **Test for %O2, % LEL, CO and H2S – Continuous monitoring**
- Ventilate prior to entry: Determined at pre entry
- Retrieval system has horizontal and stable surface around opening for firm footing.
- Visually inspect all equipment for damage or function ability
- Visually inspect the entrance for hazards, size and ease of retrieval

**5. Required Equipment:**

Personal Protective Equipment (PPE)	Entry Equipment
Clothing: long sleeves and long pants	Air Monitoring Equipment: MSA Passport or equivalent
Head Protection: Hard Hat	Communication Equipment: Vocal, two way radio
Eye Protection: Safety Glasses or Goggles	Rescue Equipment: Unihoist with retrieval winch
Hearing Protection: Ear Plugs (as needed)	Ventilation: As needed
Hand Protection: Gloves (as needed)	MSDS for potential contaminants: As needed
Foot Protection: Safety boots with rubber pull over boots as needed	Lighting: As needed
Fall Protection: Rescue harness	Lockout/Tag out: Clearance

**6. Impact on Other Operations:** None

**7. Date and Time of Entry:** \_\_\_\_\_

**8. Other Permits:** \_\_\_\_\_

**9. SOP Prepared By: names** \_\_\_\_\_

**10. Authorized Personnel** (if permit required confined space entry)

<b>Entrants Name</b>
<b>Attendant</b>
<b>Entry Supervisor</b>

**11. Confined Space Atmospheric Testing Results**

Use detector tubes, MSA Passport or other approved sampling equipment to determine atmospheric conditions. Re-evaluate atmospheric conditions and revise permit if work is stopped and the space is unoccupied for more than 30 minutes. If permit required confined space entry, monitor continuously.

Conditions	Pre-entry Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom
% Oxygen (19.5-23.5)				
% Lower Explosion Level LEL (must be <10%)				
Carbon Monoxide <20ppm				
H2S <5ppm				
Other				

**12. Rescue Plan:** City of Renton (COR) Permit-required confined spaces will only be entered into by Public Works employees when non-entry rescue can be used. Public Works employees at the City of Renton do not perform entry rescue. The following criteria must be met to be considered a non-entry rescue space:

- A. The opening is at least 18 inches in diameter.
- B. The size and stature of the entrant along with his/her PPE and any tool-belt can clear the opening.
- C. There is a horizontal and stable surface surrounding the opening to support a tripod or davit and the attendant.
- D. The weight of the entrant and his/her equipment does not exceed the rating and purpose of the retrieval winch.
- E. The length of lifeline cable is adequate for the entrant to remain attached while working in the space.
- F. The retrieval system (harness and lifeline) can be used without the entrant or harness getting caught on anything while working, or in the event he/she needs to be hoisted out of the space with the retrieval system.
- G. Once inside the space the entrant will not travel over baffles or beyond protruding pipes or obstacles in the direction of travel where the harness or lifeline could become caught.

Rescue Plan for this space would be Tripod retrieval system and call 9-1-1 in the event of an emergency.

**13. Confined Space Reclassification:**

Can this space be reclassified from a Permit CS to a Non-Permit CS: YES \_\_\_\_\_ NO  \_\_\_\_\_

**14. Job Completion Date and Time:** \_\_\_\_\_

**15. Post Entry Comments (Lessons Learned):**

We have reviewed the work authorized by this SOP/Permit and the information contained here. Written instruction and safety procedures have been received and are understood. This SOP/Permit not valid unless all appropriate items are completed.

16. Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entrant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Attendant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entry Supervisor

Send a copy of the completed permit to the Safety Department to file for 1 year.

**17. Post Entry Permit Review by Section Supervisor**

Signature \_\_\_\_\_ Date \_\_\_\_\_

Comments: This space is used to note anything that maybe unique to the space.

## Confined Space Safe Operating Plan and Permit Wet and Dry Wells

Confined Space Classification: Permanent confined space  
 Description: Wet and Dry Wells  
 Location: \_\_\_\_\_

Routine Maintenance Activities: Inspection/repair  
 \*\*\*This SOP/Permit must be submitted and kept for at least one year\*\*\*

**NOTE: If any deviations or revisions are made to this SOP, you must contact the City of Renton Risk Management Department for approval prior to such revisions.**

**2. Confined Space Criteria-Does This Space Have Any of the Following:**

- Limited access/egress: Yes
- Not made for continuous occupancy: Yes
- Large enough to bodily enter: Yes

**2. Purpose for Entry:** Inspection/repairs

**3. Known Confined Space Hazardous Conditions:** (encountered during entry or generated by the work)

- **Atmospheric:** Evaluated at pre entry.
- **Hazardous Materials Use:** NA
- **Residual Materials:** Evaluated at pre entry
- **Physical Hazards:** falls, cuts
- **Configuration Hazards:** Difficult exit, sharp objects, fall hazards
- **Engulfment hazard: Sudden unexpected flows.**

Note: This SOP was prepared for routine entries only. This SOP does not apply to work activities which may generate hazardous atmospheres. If “hot work” (welding, torch cutting, grinding) or if hazardous materials are used, additional atmospheric hazards may be generated and additional precautions may be required. The City of Renton Risk Management Department and site must be contacted prior to any non-routine entries under these conditions.

**4. Conditioning and Isolating the Space:** (Acceptable Entry Conditions if Applicable)

- Lockout/Tag-out energy sources: Yes
- Inerting/Purging/Blanking: As necessary
- Wash and flush space: Yes
- Remove all residues: NA
- Barricade access points: Yes
- Atmospheric testing: (Alarm Settings) **Test for %O2, % LEL, CO and H2S – Continuous monitoring**
- Ventilate prior to entry: Determined at pre entry
- Retrieval system has horizontal and stable surface around opening for firm footing.
- Visually inspect all equipment for damage or function ability
- Visually inspect the entrance for hazards, size and ease of retrieval
- 

**5. Required Equipment:**

Personal Protective Equipment (PPE)	Entry Equipment
Clothing: long sleeves and long pants	Air Monitoring Equipment: MSA Passport
Head Protection: Hard Hat	Communication Equipment: Vocal, two way radio
Eye Protection: Safety Glasses or Goggles	Rescue Equipment: Unihoist with retrieval winch
Hearing Protection: Ear Plugs (as needed)	Ventilation: As needed
Hand Protection: Gloves (as needed)	MSDS for potential contaminants: As needed
Foot Protection: Safety boots with rubber pull over boots	Lighting: As needed
Fall Protection: Rescue harness	Lockout/Tag out: Clearance

**6. Impact on Other Operations:** None

**7. Date and Time of Entry:** \_\_\_\_\_

**8. Other Permits:** \_\_\_\_\_

**9. SOP Prepared By:** \_\_\_\_\_

**10. Authorized Personnel** (if permit required confined space entry)

<b>Entrants Name</b>
<b>Attendant</b>
<b>Entry Supervisor</b>

**11. Confined Space Atmospheric Testing Results**

Use detector tubes, MSA Passport or other approved sampling equipment to determine atmospheric conditions. Re-evaluate atmospheric conditions and revise permit if work is stopped and the space is unoccupied for more than 30 minutes. If permit required confined space entry, monitor continuously.

Conditions	Pre-entry Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom
% Oxygen (19.5-23.5)				
% Lower Explosion Level LEL (must be <10%)				
Carbon Monoxide 20ppm				
H2S <5ppm				
Other				

**12. Rescue Plan:** City of Renton (COR) Permit-required confined spaces will only be entered into by Public Works employees when non-entry rescue can be used. Public Works employees at the City of Renton do not perform entry rescue. The following criteria must be met to be considered a non-entry rescue space:

- A. The opening is at least 18 inches in diameter.
- B. The size and stature of the entrant along with his/her PPE and any tool-belt can clear the opening.
- C. There is a horizontal and stable surface surrounding the opening to support a tripod or davit and the attendant.
- D. The weight of the entrant and his/her equipment does not exceed the rating and purpose of the retrieval winch.
- E. The length of lifeline cable is adequate for the entrant to remain attached while working in the space.
- F. The retrieval system (harness and lifeline) can be used without the entrant or harness getting caught on anything while working, or in the event he/she needs to be hoisted out of the space with the retrieval system.
- G. Once inside the space the entrant will not travel over baffles or beyond protruding pipes or obstacles in the direction of travel where the harness or lifeline could become caught.

Rescue Plan for this space would be Tripod retrieval system and call 9-1-1 in the event of an emergency.

**13. Confined Space Reclassification:**

Can this space be reclassified from a Permit CS to a Non-Permit CS: YES \_\_\_\_\_ NO X \_\_\_\_\_

**14. Job Completion Date and Time:** \_\_\_\_\_

**15. Post Entry Comments (Lessons Learned):**

16. Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entrant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Attendant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entry Supervisor

\*\* All City of Renton employees involved in confined space work must complete an approved Confined Space Entry Training Course Contact the City of Renton Risk Management Department for Training Information.

Send a copy of the completed permit to the Safety Department to file for 1 year.

**17. Post Entry Permit Review by Section Supervisor**

Signature \_\_\_\_\_ Date \_\_\_\_\_

Comments: This space is used to note anything that maybe unique to the space.

## Confined Space Safe Operating and Permit – Chemical Vault

**Confined Space Classification:** Permit-Required confined space  
**Description:** Chemical Vault  
**Location:** 4000 Maple Valley HWY  
**Routine Maintenance Activities:** Inspection/repair/cleaning

\*\*\*This SOP/Permit must be submitted and kept for at least one year\*\*\*

**NOTE:** If any deviations or revisions are made to this SOP, you must contact the City of Renton Risk Management Department for approval prior to such revisions.

**3. Confined Space Criteria-Does This Space Have Any of the Following:**

- Limited access/egress: Yes
- Not made for continuous occupancy: Yes
- Large enough to bodily enter: Yes
- Potential to contain a hazardous atmosphere: Yes
- 

**4. Purpose for Entry:** Inspection/repairs/cleaning

**5. Known Confined Space Hazardous Conditions:**

- **Atmospheric:** Oxygen deficient
- **Hazardous Materials Use:** N/A
- **Residual Materials:** Sodium Hypochlorite
- **Physical Hazards:** falls
- **Configuration Hazards:** fall hazards

Note: This SOP was prepared for routine entries only. This SOP does not apply to work activities which may generate hazardous atmospheres. If “hot work” (welding, torch cutting, grinding) or if hazardous materials are used, additional atmospheric hazards may be generated and additional precautions may be required. The City of Renton Risk Management Department and site must be contacted prior to any non-routine entries under these conditions.

**4. Conditioning and Isolating the Space:** (Acceptable Entry Conditions if Applicable)

- Lockout/Tag out energy sources: Close and tag main line water valves
- Inserting/Purging/Blanking: Purge with breathable air
- Wash and flush space: (N/A)
- Barricade access points: Hatches will be blocked by rails
- Atmospheric testing: (Alarm Settings) **Test for %O2, % LEL, CO and H2S – Continuous monitoring**
- Ventilate prior to entry: Constant flow of breathable air
- Retrieval system has horizontal and stable surface around opening for firm footing
- Visually inspect all equipment for damage or function ability
- Visually inspect the entrance for hazards, size and ease of retrieval

**5. Required Equipment:**

Personal Protective Equipment (PPE)	Entry Equipment
Clothing: Rain gear that is approved to repel Sodium Hypochlorite. Long sleeve and long pants	Air Monitoring Equipment: MSA Passport or equivalent
Head Protection: Hard Hat	Communication Equipment: Vocal
Eye Protection: Safety Glasses or Goggles	Rescue Equipment: Unihoist with retrieval winch for fall protection
Hearing Protection: Ear Plugs (as needed)	Ventilation: Fan continuous
Hand Protection: Gloves (as needed)	MSDS N/A
Foot Protection: Safety boots with rubber pull over boots	Lighting:
Fall Protection: Rescue harness	Lockout/Tag out: Clearance

- 6. Impact on Other Operations:** None  
**7. Date and Time of Entry:** \_\_\_\_\_  
**8. Other Permits:** \_\_\_\_\_  
**9. SOP Prepared By:** \_\_\_\_\_

10. **Authorized Personnel** (if permit required confined space entry)

<b>Entrants Name</b>
<b>Attendant</b>
<b>Entry Supervisor</b>

11. **Confined Space Atmospheric Testing Results**

Use detector tubes, MSA Passport or other approved sampling equipment to determine atmospheric conditions. Re-evaluate atmospheric conditions and revise permit if work is stopped and the space is unoccupied for more than 30 minutes. If permit required confined space entry, monitor continuously.

Conditions	Pre-entry Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom
% Oxygen (19.5-23.5)				
% Lower Explosion Level LEL (must be <10%)				
Carbon Monoxide <20ppm				
H2S <5ppm				
Other				

12. **Rescue Plan:** City of Renton (COR) Permit-required confined spaces will only be entered into by Public Works employees when non-entry rescue can be used. Public Works employees at the City of Renton do not perform entry rescue. The following criteria must be met to be considered a non-entry rescue space:

- A. The opening is at least 18 inches in diameter.
- B. The size and stature of the entrant along with his/her PPE and any tool-belt can clear the opening.
- C. There is a horizontal and stable surface surrounding the opening to support a tripod or davit and the attendant.
- D. The weight of the entrant and his/her equipment does not exceed the rating and purpose of the retrieval winch.
- E. The length of lifeline cable is adequate for the entrant to remain attached while working in the space.
- F. The retrieval system (harness and lifeline) can be used without the entrant or harness getting caught on anything while working, or in the event he/she needs to be hoisted out of the space with the retrieval system.
- G. Once inside the space the entrant will not travel over baffles or beyond protruding pipes or obstacles in the direction of travel where the harness or lifeline could become caught.

Rescue Plan for this space would be Tripod retrieval system and call 9-1-1 in the event of an emergency.

13. **Confined Space Reclassification:**

Can this space be reclassified from a Permit CS to a Non-Permit CS: YES \_\_\_\_\_ NO  X \_\_\_\_\_

14. **Job Completion Date and Time:** \_\_\_\_\_

15. **Post Entry Comments (Lessons Learned):**

We have reviewed the work authorized by this SOP/Permit and the information contained here. Written instruction and safety procedures have been received and are understood. This SOP/Permit not valid unless all appropriate items are completed.

16. Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entrant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Attendant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entry Supervisor

\*\* All City of Renton employees involved in confined space work must complete an approved Confined Space Entry Training Course Contact the City of Renton Risk Management Department for Training Information.

Send a copy of the completed permit to the Safety Department to file for 1 year.

17. **Post Entry Permit Review by Section Supervisor**

Signature \_\_\_\_\_ Date \_\_\_\_\_

Comments: This space is used to note anything that maybe unique to the space.

## Confined Space Safe Operating Plan and Permit – PRV Vaults

**Confined Space Classification:** Permit-Required Confined Space

**Description:** \_\_\_\_\_

**Location:** \_\_\_\_\_

**Routine Maintenance Activities:** Inspection/repair/cleaning

\*\*\*This SOP/Permit must be submitted and kept for at least one year\*\*\*

**NOTE: If any deviations from or revisions to this SOP need to be made, you must contact the City of Renton Risk Management Department for approval prior to such revisions.**

**1. Confined Space Criteria- Does This Space Have All of the Following:**

- Limited access/egress: Yes
- Not made for continuous human occupancy: Yes
- Large enough to bodily enter and perform work: Yes

**2. Purpose for Entry:** Inspection/repairs/cleaning

**3. Known Confined Space Hazardous Conditions:**

- **Atmospheric:** Possible Oxygen deficiency from oxidation
- **Hazardous Materials Use:** N/A
- **Residual Materials:** N/A
- **Physical Hazards:** Remote risk of engulfment in event of pipe or valve failure inside vault and possible electrical hazards if power is in vault. Follow all lock-out/ tag-out procedures to de-energize potential dangers
- **Configuration Hazards:** N/A

Note: This SOP was prepared for routine entries only. This SOP does not apply to work activities which may generate hazardous atmospheres. If “hot work” (welding, torch cutting, grinding) or if hazardous materials are used, additional atmospheric hazards may be generated and additional precautions may be required. The City of Renton Risk Management Department and site must be contacted prior to any non-routine entries under these conditions.

**4. Conditioning and Isolating the Space:** (Acceptable Entry Conditions if Applicable)

- Lockout/Tag out energy sources: If pump to be disassembled, follow separate lockout/tag-out procedures, including closing, locking out and tagging out main line water valves and by-pass valves; double block and bleed feeder lines
- Inserting/Purging: (N/A)
- Wash and flush space: (N/A)
- Barricade access points: Hatches will be blocked by rails
- Atmospheric testing: (Alarm Settings) %O<sub>2</sub> must be > 19.5% but < 23.5%; % LEL must be < 10%; CO must be < 20ppm; H<sub>2</sub>S must be < 5ppm – Continuous monitoring required with monitor from outside space (operated by attendant or supervisor) with hose extension into space
- Ventilate prior to entry: Constant flow of breathable air (at least 5x/hour ventilation rate with blower)
- Retrieval system has horizontal and stable surface around opening for firm footing
- Visually inspect all equipment for damage or function ability
- Visually inspect the entrance for hazards, size and ease of retrieval

**5. Required Equipment:**

Personal Protective Equipment (PPE)	Entry Equipment
Clothing: long sleeves and long pants	Air Monitoring Equipment: MSA Passport or equivalent multi-gas detector
Head Protection: Hard Hat	Communication Equipment: Vocal
Eye Protection: Safety Glasses or Goggles	Rescue Equipment: Davit retrieval system
Hearing Protection: Ear Plugs (as needed)	Ventilation: Blower continuous
Hand Protection: Gloves (as needed)	Lock out/tag out: clearance
Foot Protection: Safety boots with rubber pull over boots	Lighting: portable lighting as needed

**6. Impact on Other Operations:** None

**7. Date and Time of Entry:** \_\_\_\_\_

**8. Other Permits needed:** \_\_\_\_\_ None \_\_\_\_\_

**9. SOP Prepared By:** \_\_\_\_\_

**10. Authorized Personnel** (if permit required confined space entry)

Entrants Name(s)
Attendant
Entry Supervisor

**11. Confined Space Atmospheric Testing Results**

Use MSA Passport, or equivalent multi-gas detector, or other safety-department-approved air sampling equipment to determine atmospheric conditions. Re-evaluate atmospheric conditions and revise permit if work is stopped and the space is unoccupied for more than 30 minutes. If permit required confined space entry, monitor continuously.

Air Sampling Readings	Pre-entry Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom
% Oxygen (19.5-23.5)				
% Lower Explosive Limit LEL (must be <10%)				
Carbon Monoxide <20ppm				
H2S <5ppm				
Other				

**12. Rescue Plan:** City of Renton (COR) Permit-required confined spaces will only be entered into by Public Works employees when non-entry rescue can be used. Public Works employees at the City of Renton do not perform entry rescue. The following criteria must be met to be considered a non-entry rescue space:

- A. The opening is at least 18 inches in diameter.
- B. The size and stature of the entrant along with his/her PPE and any tool-belt can clear the opening.
- C. There is a horizontal and stable surface surrounding the opening to support a tripod or davit and the attendant.
- D. The weight of the entrant and his/her equipment does not exceed the rating and purpose of the retrieval winch.
- E. The length of lifeline cable is adequate for the entrant to remain attached while working in the space.
- F. The retrieval system (harness and lifeline) can be used without the entrant or harness getting caught on anything while working, or in the event he/she needs to be hoisted out of the space with the retrieval system.
- G. Once inside the space the entrant will not travel over baffles or beyond protruding pipes or obstacles in the direction of travel where the harness or lifeline could become caught.

**Rescue Plan:** Non-entry rescue is acceptable. Entrant to be extracted by attendant using Davit/winch for retrieval and call for medical assistance as needed.

**13. Confined Space Reclassification:**

Can this space be reclassified from a Permit CS to a Non-Permit CS: Yes \_\_\_\_\_ No X\_\_\_\_\_

**14. Job Completion Date and Time:**

**15. Post Entry Comments (Lessons Learned)**

We have reviewed the work authorized by this SOP/Permit and the information contained here. Written instruction and safety procedures have been received and are understood. This SOP/Permit not valid unless all appropriate items are completed.

16. Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entrant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Attendant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entry Supervisor

Send a copy of the completed permit to the Safety Department to file for 1 year.

**17. Post Entry Permit Review by Section Supervisor**

Signature \_\_\_\_\_ Date \_\_\_\_\_

Comments: This space is used to note anything that maybe unique to the space.

## Confined Space Safe Operating Plan and Permit – Reservoir

**Confined Space Classification:** Permit-Required confined space

**Description:** Water Reservoir

**Location:** \_\_\_\_\_

**Routine Maintenance Activities:** Inspection/repair/cleaning

\*\*\*This SOP/Permit must be submitted and kept on file for 1 year.\*\*\*

**NOTE: If any deviations or revisions are made to this SOP, you must contact the City of Renton Risk Management Department for approval prior to such revisions.**

**6. Confined Space Criteria-Does This Space Have Any of the Following:**

- Limited access/egress: Yes
- Not made for continuous occupancy: Yes
- Large enough to bodily enter: Yes
- \_\_\_\_\_

**7. Purpose for Entry:** Inspection/repairs/cleaning

**8. Known Confined Space Hazardous Conditions:**

- Atmospheric: Oxygen deficient
- Hazardous Materials Use: Chlorine solution
- Residual Materials: None
- Physical Hazards: falls
- Configuration Hazards: fall hazards

Note: This SOP was prepared for routine entries only. This SOP does not apply to work activities which may generate hazardous atmospheres. If “hot work” (welding, torch cutting, grinding) or if hazardous materials are used, additional atmospheric hazards may be generated and additional precautions may be required. The City of Renton Risk Management Department and site must be contacted prior to any non-routine entries under these conditions.

**4. Conditioning and Isolating the Space:** (Acceptable Entry Conditions if Applicable)

- Lockout/Tag out energy sources: Close and tag main line water valves
- Inerting/Purging/Blanking: Purge with breathable air
- Wash and flush space: (N/A)
- Barricade access points: Hatches will be blocked by rails
- Atmospheric testing: (Alarm Settings) **Test for %O2, % LEL, CO and H2S – Continuous monitoring**
- Ventilate prior to entry: Constant flow of breathable air
- Retrieval system has horizontal and stable surface around opening for firm footing.
- Visually inspect all equipment for damage or function ability
- Visually inspect the entrance for hazards, size and ease of retrieval

**5. Required Equipment:**

Personal Protective Equipment (PPE)	Entry Equipment
Clothing: long sleeves and long pants	Air Monitoring Equipment: MSA Passport or equivalent
Head Protection: Hard Hat	Communication Equipment: Vocal
Eye Protection: Safety Glasses or Goggles	Rescue Equipment: Unihoist with retrieval winch for fall protection
Hearing Protection: Ear Plugs (as needed)	Ventilation: Fan continuous
Hand Protection: Gloves (as needed)	MSDS N/A
Foot Protection: Safety boots with rubber pull over boots	Lighting:
Fall Protection: Rescue harness	Lockout/Tag out: Clearance

**6. Impact on Other Operations:** None

**7. Date and Time of Entry:** \_\_\_\_\_

**8. Other Permits:** \_\_\_\_\_

**9. SOP Prepared By:** \_\_\_\_\_

**10. Authorized Personnel** (if permit required confined space entry)

<b>Entrants Name</b>
<b>Attendant</b>
<b>Entry Supervisor</b>

**11. Confined Space Atmospheric Testing Results**

Use detector tubes, MSA Passport or other approved sampling equipment to determine atmospheric conditions. Re-evaluate atmospheric conditions and revise permit if work is stopped and the space is unoccupied for more than 30 minutes. If permit required confined space entry, monitor continuously.

Conditions	Pre-entry Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom
% Oxygen (19.5-23.5)				
% Lower Explosion Level LEL (must be <10%)				
Carbon Monoxide <20ppm				
H2S <5ppm				
Other				

**12. Rescue Plan:** City of Renton (COR) Permit-required confined spaces will only be entered into by Public Works employees when non-entry rescue can be used. Public Works employees at the City of Renton do not perform entry rescue. The following criteria must be met to be considered a non-entry rescue space:

- A. The opening is at least 18 inches in diameter.
- B. The size and stature of the entrant along with his/her PPE and any tool-belt can clear the opening.
- C. There is a horizontal and stable surface surrounding the opening to support a tripod or davit and the attendant.
- D. The weight of the entrant and his/her equipment does not exceed the rating and purpose of the retrieval winch.
- E. The length of lifeline cable is adequate for the entrant to remain attached while working in the space.
- F. The retrieval system (harness and lifeline) can be used without the entrant or harness getting caught on anything while working, or in the event he/she needs to be hoisted out of the space with the retrieval system.
- G. Once inside the space the entrant will not travel over baffles or beyond protruding pipes or obstacles in the direction of travel where the harness or lifeline could become caught.

Rescue Plan for this space would be Tripod retrieval system and call 9-1-1 in the event of an emergency

**13. Confined Space Reclassification:**

Can this space be reclassified from a Permit CS to a Non-Permit CS: YES  NO

**14. Job Completion Date and Time:**

**15. Post Entry Comments (Lessons Learned):**

We have reviewed the work authorized by this SOP/Permit and the information contained here. Written instruction and safety procedures have been received and are understood. This SOP/Permit not valid unless all appropriate items are completed.

16. Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entrant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Attendant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entry Supervisor

\*\* All City of Renton employees involved in confined space work must complete an approved Confined Space Entry Training Course Contact the City of Renton Risk Management Department for Training Information.

Send a copy of the completed permit to the Safety Department to file for 1 year.

**17. Post Entry Permit Review by Section Supervisor**

Signature \_\_\_\_\_ Date \_\_\_\_\_

Comments: This space is used to note anything that maybe unique to the space.

## Confined Space Safe Operating Plan and Permit Water Storage Tanks

Confined Space Classification: Permit-Required confined space

Description: Water Storage Tanks

Location: All Tanks

Routine Maintenance Activities: Inspection/repair/cleaning

\*\*\*This SOP/Permit must be submitted and kept for at least one year\*\*\*

**NOTE: If any deviations or revisions are made to this SOP, you must contact the City of Renton Risk Management Department for approval prior to such revisions.**

**9. Confined Space Criteria-Does This Space Have Any of the Following:**

- Limited access/egress: Yes
- Not made for continuous occupancy: Yes
- Large enough to bodily enter: Yes
- Potential to contain a hazardous atmosphere: Yes

10. Purpose for Entry: Inspection/repairs/cleaning

**11. Known Confined Space Hazardous Conditions:**

- **Atmospheric:** Oxygen deficient
- **Hazardous Materials Use:** Chlorine solution
- **Residual Materials:** None
- **Physical Hazards:** falls
- **Configuration Hazards:** fall hazards

Note: This SOP was prepared for routine entries only. This SOP does not apply to work activities which may generate hazardous atmospheres. If "hot work" (welding, torch cutting, grinding) or if hazardous materials are used, additional atmospheric hazards may be generated and additional precautions may be required. The City of Renton Risk Management Department and site must be contacted prior to any non-routine entries under these conditions.

**4. Conditioning and Isolating the Space:** (Acceptable Entry Conditions if Applicable)

- Lockout/Tag out energy sources: Close and tag main line water valves
- Inserting/Purging/Blanking: Purge with breathable air
- Wash and flush space: (N/A)
- Barricade access points: Hatches will be blocked by rails
- Atmospheric testing: (Alarm Settings) **Test for %O2, % LEL, CO and H2S – Continuous monitoring**
- Ventilate prior to entry: Constant flow of breathable air
- Retrieval system has horizontal and stable surface around opening for firm footing
- Visually inspect all equipment for damage or function ability
- Visually inspect the entrance for hazards, size and ease of retrieval

**5. Required Equipment:**

Personal Protective Equipment (PPE)	Entry Equipment
Clothing: long sleeves and long pants	Air Monitoring Equipment: MSA Passport or equivalent
Head Protection: Hard Hat (as needed)	Communication Equipment: Vocal
Eye Protection: Safety Glasses or Goggles	Rescue Equipment: Unihoist with retrieval winch for fall protection when needed
Hearing Protection: Ear Plugs (as needed)	Ventilation: Fan continuous
Hand Protection: Gloves (as needed)	MSDS N/A
Foot Protection: Safety boots with rubber pull over boots	Lighting:
Fall Protection: Rescue harness	Lockout/Tag out: Clearance

6. Impact on Other Operations: None

7. Date and Time of Entry: \_\_\_\_\_

8. Other Permits: \_\_\_\_\_

9. SOP Prepared By: \_\_\_\_\_

10. **Authorized Personnel** (if permit required confined space entry)

Entrants Name
Attendant
Entry Supervisor

11. **Confined Space Atmospheric Testing Results**

Use detector tubes, MSA Passport or other approved sampling equipment to determine atmospheric conditions. Re-evaluate atmospheric conditions and revise permit if work is stopped and the space is unoccupied for more than 30 minutes. If permit required confined space entry, monitor continuously.

Conditions	Pre-entry Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom
% Oxygen (19.5-23.5)				
% Lower Explosion Level LEL (must be <10%)				
Carbon Monoxide <20ppm				
H2S <5ppm				
Other				

12. **Rescue Plan:** City of Renton (COR) Permit-required confined spaces will only be entered into by Public Works employees when non-entry rescue can be used. Public Works employees at the City of Renton do not perform entry rescue. The following criteria must be met to be considered a non-entry rescue space:

- A. The opening is at least 18 inches in diameter.
- B. The size and stature of the entrant along with his/her PPE and any tool-belt can clear the opening.
- C. There is a horizontal and stable surface surrounding the opening to support a tripod or davit and the attendant.
- D. The weight of the entrant and his/her equipment does not exceed the rating and purpose of the retrieval winch.
- E. The length of lifeline cable is adequate for the entrant to remain attached while working in the space.
- F. The retrieval system (harness and lifeline) can be used without the entrant or harness getting caught on anything while working, or in the event he/she needs to be hoisted out of the space with the retrieval system.
- G. Once inside the space the entrant will not travel over baffles or beyond protruding pipes or obstacles in the direction of travel where the harness or lifeline could become caught.

Rescue Plan for this space would be Tripod retrieval system and call 9-1-1 in the event of an emergency.

13. **Confined Space Reclassification:**

Can this space be reclassified from a Permit CS to a Non-Permit CS: YES X NO \_\_\_\_\_

14. **Job Completion Date and Time:** \_\_\_\_\_

15. **Post Entry Comments (Lessons Learned):**

We have reviewed the work authorized by this SOP/Permit and the information contained here. Written instruction and safety procedures have been received and are understood. This SOP/Permit not valid unless all appropriate items are completed.

16. Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entrant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Attendant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entry Supervisor

Send a copy of the completed permit to the Safety Department to file for 1 year.

17. **Post Entry Permit Review by Section Supervisor**

Signature \_\_\_\_\_ Date \_\_\_\_\_

Comments: This space is used to note anything that maybe unique to the space.

## Confined Space Safe Operating Plan and Permit – Tanks

**Confined Space Classification:** Permit-Required confined space  
**Description:** Surface Water Tanks  
**Location:** \_\_\_\_\_

**Routine Maintenance Activities:** Inspection/repair  
 \*\*\*This SOP/Permit must be submitted and kept for a least one year\*\*\*

**NOTE:** If any deviations or revisions are made to this SOP, you must contact the City of Renton Risk Management Department for approval prior to such revisions.

**12. Confined Space Criteria-Does This Space Have Any of the Following:**

- Limited access/egress: Yes
- Not made for continuous occupancy: Yes
- Large enough to bodily enter: Yes

2. **Purpose for Entry:** Inspection/repairs

3. **Known Confined Space Hazardous Conditions:** (encountered during entry or generated by the work)

- **Atmospheric:** Evaluated at pre entry.
- **Hazardous Materials Use:** NA
- **Residual Materials:** Evaluated at pre entry
- **Physical Hazards:** falls, cuts
- **Configuration Hazards:** Difficult exit, sharp objects, fall hazards
- **Engulfment hazard:** Sudden unexpected flows.

Note: This SOP was prepared for routine entries only. This SOP does not apply to work activities which may generate hazardous atmospheres. If “hot work” (welding, torch cutting, grinding) or if hazardous materials are used, additional atmospheric hazards may be generated and additional precautions may be required. The City of Renton Risk Management Department and site must be contacted prior to any non-routine entries under these conditions.

4. **Conditioning and Isolating the Space:** (Acceptable Entry Conditions if Applicable)

- Lockout/Tag out energy sources: NA
- Inserting/Purging/Blanking: Vacuum, purge with breathable air
- Wash and flush space: Yes
- Remove all residues: NA
- Barricade access points: Yes
- Atmospheric testing: (Alarm Settings) **Test for %O2, % LEL, CO and H2S – Continuous monitoring**
- Ventilate prior to entry: Determined at pre entry
- Retrieval system has horizontal and stable surface around opening for firm footing
- Visually inspect all equipment for damages or function ability
- Visually inspect the entrance for hazards, size and ease of retrieval
- 

5. **Required Equipment:**

Personal Protective Equipment (PPE)	Entry Equipment
Clothing: long sleeves and long pants	Air Monitoring Equipment: MSA Passport or equivalent
Head Protection: Hard Hat	Communication Equipment: Vocal, two way radio
Eye Protection: Safety Glasses or Goggles	Rescue Equipment: Unihoist with retrieval winch
Hearing Protection: Ear Plugs (as needed)	Ventilation: As needed
Hand Protection: Gloves (as needed)	MSDS for potential contaminants: As needed
Foot Protection: Safety boots with rubber pull over boots as needed	Lighting: As needed
Fall Protection: Rescue harness	Lockout/Tag out: Clearance

6. **Impact on Other Operations:** None

7. **Date and Time of Entry:** \_\_\_\_\_

8. **Other Permits:** \_\_\_\_\_

9. **SOP Prepared By:** \_\_\_\_\_

10. **Authorized Personnel** (if permit required confined space entry)

Entrants Name
Attendant
Entry Supervisor

11. **Confined Space Atmospheric Testing Results**

Use detector tubes, MSA Passport or other approved sampling equipment to determine atmospheric conditions. Re-evaluate atmospheric conditions and revise permit if work is stopped and the space is unoccupied for more than 30 minutes. If permit required confined space entry, monitor continuously.

Conditions	Pre-entry Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom	During Work Top/Mid/Bottom
% Oxygen (19.5-23.5)				
% Lower Explosion Level LEL (must be <10%)				
Carbon Monoxide <20ppm				
H2S <5ppm				
Other				

12. **Rescue Plan:** City of Renton (COR) Permit-required confined spaces will only be entered into by Public Works employees when non-entry rescue can be used. Public Works employees at the City of Renton do not perform entry rescue. The following criteria must be met to be considered a non-entry rescue space:

- A. The opening is at least 18 inches in diameter.
- B. The size and stature of the entrant along with his/her PPE and any tool-belt can clear the opening.
- C. There is a horizontal and stable surface surrounding the opening to support a tripod or davit and the attendant.
- D. The weight of the entrant and his/her equipment does not exceed the rating and purpose of the retrieval winch.
- E. The length of lifeline cable is adequate for the entrant to remain attached while working in the space.
- F. The retrieval system (harness and lifeline) can be used without the entrant or harness getting caught on anything while working, or in the event he/she needs to be hoisted out of the space with the retrieval system.
- G. Once inside the space the entrant will not travel over baffles or beyond protruding pipes or obstacles in the direction of travel where the harness or lifeline could become caught.

Rescue Plan for this space would be Tripod retrieval system and call 9-1-1 in the event of an emergency.

13. **Confined Space Reclassification:**

Can this space be reclassified from a Permit CS to a Non-Permit CS: YES \_\_\_\_\_ NO X \_\_\_\_\_

14. **Job Completion Date and Time:** \_\_\_\_\_

15. **Post Entry Comments (Lessons Learned):** \_\_\_\_\_  
 \_\_\_\_\_

We have reviewed the work authorized by this SOP/Permit and the information contained here. Written instruction and safety procedures have been received and are understood. This SOP/Permit not valid unless all appropriate items are completed.

16. Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entrant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Attendant  
 Signature \_\_\_\_\_ Date \_\_\_\_\_ Title - Entry Supervisor

Send a copy of the completed permit to the Safety Department to file for 1 year.

17. **Post Entry Permit Review by Section Supervisor**

Signature \_\_\_\_\_ Date \_\_\_\_\_

Comments: This space is used to note anything that maybe unique to the space.

## APPENDIX C: HOT WORK PERMIT

### BEFORE INITIATING HOT WORK, CAN THIS JOB BE AVOIDED? IS THERE A SAFER WAY?

This Hot Work Permit is required for any temporary operation involving open flames or producing heat and/or sparks. This includes, but is not limited to: brazing, cutting grinding, and soldering, thawing pipe, torch applied roofing, and welding.

A Fire Watch should be posted 1) if combustible materials within a 35-foot radius of hot work cannot be removed; 2) if wall/floor openings within a 35-foot radius of hot work exposed combustible materials in adjacent areas, including concealed spaces in walls or floors; 3) if combustible materials are adjacent to the opposite side of partitions, walls, ceilings or roofs and are likely to be ignited; or 4) it is deemed necessary by the Permit Authorizing Individual.

DATE \_\_\_\_\_

LOCATION/BUILDING & FLOOR (Be Specific)  
\_\_\_\_\_

DESCRIPTION OF WORK BEING PERFORMED  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**The above location has been examined, the precautions checked on the Hot Work Checklist have been taken to prevent fire, and permission is authorized for this work.**

SIGNED: \_\_\_\_\_  
(Permit Authorizing Individual)

SIGNED: \_\_\_\_\_  
(Person doing Hot Work)

SIGNED: \_\_\_\_\_  
(Fire Watch)

#### PERMIT CHECKLIST

OK		N/A
<input type="checkbox"/>	Flammable and combustible materials within a 35-ft radius of hot work have been removed or covered with fire retardant tarps or material shields	<input type="checkbox"/>
<input type="checkbox"/>	All floors and surfaces within a 35ft radius of hot work area have been swept free of combustible dust/debris	<input type="checkbox"/>
<input type="checkbox"/>	Any openings or cracks in the walls, floors, or ducts that are potential travel passes for sparks, heat and flames have been covered	<input type="checkbox"/>
<input type="checkbox"/>	An operable fire extinguisher is nearby and accessible.	<input type="checkbox"/>
<input type="checkbox"/>	Sprinkler heads that could be activated by hot work have been covered with a wet rag.	<input type="checkbox"/>
<input type="checkbox"/>	Smoke detectors in the area of hot work have been covered to prevent false alarms.	<input type="checkbox"/>
<input type="checkbox"/>	A Fire Watch has been posted, if required, during hot work operations and for 30 minutes after work is completed.	<input type="checkbox"/>

#### HOT WORK CHECKLIST

<input type="checkbox"/>	Available sprinklers, hose streams, and extinguishers are in service/operable.	<input type="checkbox"/>
<input type="checkbox"/>	Hot work equipment in good repair.	<input type="checkbox"/>

#### HOT WORK CHECKLIST CONTINUED

OK		N/A
<b>REQUIREMENTS WITHIN 35 FEET OF WORK</b>		
<input type="checkbox"/>	Flammable liquids, dust, lint and oil deposits removed	<input type="checkbox"/>
<input type="checkbox"/>	Explosive atmosphere in area eliminated.	<input type="checkbox"/>
<input type="checkbox"/>	Floors swept clean of combustibles.	<input type="checkbox"/>
<input type="checkbox"/>	Combustible floors wet down, covered with damp sand or fire-resistant sheets	<input type="checkbox"/>
<input type="checkbox"/>	All wall and floor openings covered.	<input type="checkbox"/>
<input type="checkbox"/>	Remove other combustibles where possible. Otherwise protect with fire-resistant tarpaulins, screens or shields.	<input type="checkbox"/>

#### WORK ON WALLS OR CEILINGS

<input type="checkbox"/>	Construction is noncombustible and without combustible coverings or insulation.	<input type="checkbox"/>
<input type="checkbox"/>	Combustibles on other side of walls moved away.	<input type="checkbox"/>
<input type="checkbox"/>	No danger exists by conduction of heat into another room or area.	<input type="checkbox"/>
<input type="checkbox"/>	Enclosed equipment cleaned of all combustibles.	<input type="checkbox"/>
<input type="checkbox"/>	Containers purged of flammable liquids and vapors.	<input type="checkbox"/>

#### FIRE WATCH/HOT WORK AREA MONITORING

<input type="checkbox"/>	Fire watch will be provided during & continuously for 30 min after work, including during any work breaks.	<input type="checkbox"/>
<input type="checkbox"/>	Fire watch is supplied with suitable extinguishers. Fire watch is trained in use of this equipment and in sounding alarm.	<input type="checkbox"/>
<input type="checkbox"/>	Fire watch may be required for adjoining areas, above and below.	<input type="checkbox"/>
<input type="checkbox"/>	Hot work area inspected 30 minutes after job is completed.	<input type="checkbox"/>

#### OTHER PRECAUTIONS TAKEN

<input type="checkbox"/>	Continuous ventilation.	<input type="checkbox"/>
<input type="checkbox"/>	Area is protected with smoke or heat detection.	<input type="checkbox"/>
<input type="checkbox"/>	Ample ventilation to remove smoke/vapor from work area.	<input type="checkbox"/>
<input type="checkbox"/>	Lockout/tag out required.	<input type="checkbox"/>
<input type="checkbox"/>	Air monitored.	<input type="checkbox"/>
<input type="checkbox"/>	Confined space entry permit required.	<input type="checkbox"/>

**All checkboxes must be completed or form is not valid and cannot be used.**

Last Updated ~~10/4/2012~~ 10/1/2012

**APPENDIX D: MANUFACTURER'S OPERATOR MANUAL**

# **G450**

## **Multi-gas Detector**

### **Field Operation Manual**



**GfG Instrumentation**

1194 Oak Valley Dr, Ste 20, Ann Arbor MI 48108 USA  
(800) 959-0329 • (734) 769-0573 • [www.gfg-inc.com](http://www.gfg-inc.com)

## Warranty

GfG Instrumentation warrants our products to be free from defects in material and workmanship when used for their intended purpose, and agrees to remedy such defect or to furnish a new part (at the option of GfG Instrumentation) in exchange for any part of any product we manufacture that under normal use is found to be defective; provided that the product is returned by the purchaser to GfG's factory, intact, for our examination, with all transportation costs prepaid, and provided that such examinations reveals, in our judgment, that it is defective.

This warranty does not extend to any products that have been subjected to misuse, neglect, accident or unauthorized modifications; nor does it extend to products used contrary to the instructions furnished by us or to products that have been repaired or altered outside of our factory or by a non-authorized service center. No agent or reseller of GfG Instrumentation may alter the above statement.

This warranty is expressly in lieu of any and all other warranties and representations, express or implied, including but not limited to, the warranty of fitness for a particular purpose. GfG will not be liable for loss or damage of any kind connected to the use of its products or failure of its products to function or operate properly.

The G450 has a limited lifetime warranty to the original purchaser (as long as the instrument is in service). Accessories (battery packs and chargers, sampling pumps and other components), which by their design are consumed or depleted during normal operation, or which may require periodic replacement are warranted for one year from the date of purchase. O<sub>2</sub>, LEL, CO, and H<sub>2</sub>S sensors are covered for 3 years from date of purchase.

## Introduction

The purpose of this manual is to provide day-to-day basic information for the G450. Please refer to the accompanying CD-ROM to access the complete user's manual. The G450 is a handheld detector for personal protection from gas hazards. The instrument measures continuously in diffusion mode and gives visual and audible alarms if a gas-induced danger arises.

The G450 is a safety device and it is up to the user to ensure proper action is taken in the event of an alarm.

The following signal words, as defined by ANSI Z535.4-1998, are used in this guide.

**▲DANGER** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

**▲WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

**▲CAUTION** indicates a potentially hazardous situation, which if not avoided, may result in moderate or minor injury.

## Safety Information

The G450 must only be operated as specified in this manual, otherwise the instrument's protection may be diminished. Please refer to ISA-RP12.13, Part II-1987 for guidance in use of this instrument.

### Warnings

**▲WARNING** Never substitute any component as this may compromise the G450s intrinsic safety.

**▲WARNING** For safety reasons, this equipment must be operated and serviced by qualified personnel only. Read and understand the instruction manual completely before operating or servicing the G450.

**▲WARNING** Instrument should be calibrated before first time use and then on a regular basis. Length of interval will depend on frequency of use and contaminants and/or poisons being exposed to the sensors. GfG recommends a minimum of 180 days.

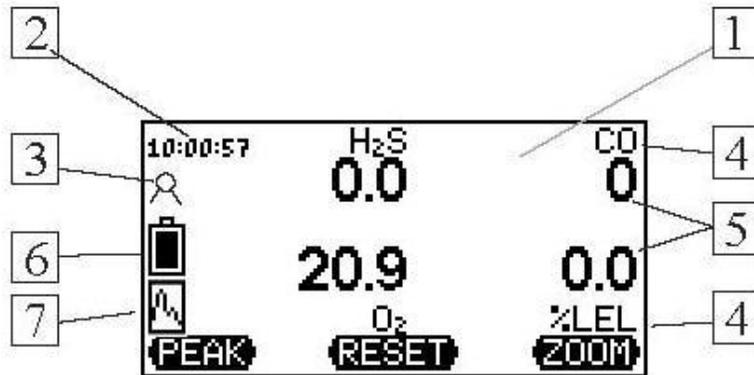
**▲WARNING** If the combustible sensor may be exposed to a known poison (silicon, sulfur, halogenated compounds, etc), GfG recommends checking it against a known concentration of calibration gas before use.

## Design

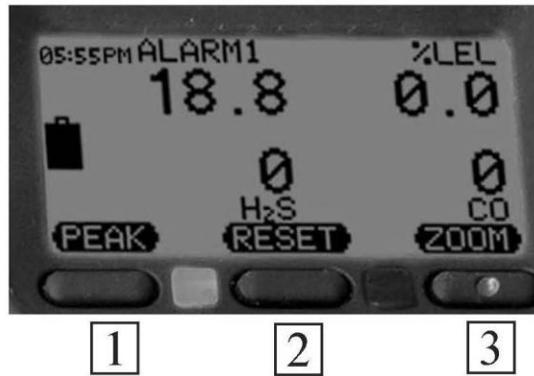


Item	Description
1	Hook for carrying strap
2	Display
3	Keys
4	Alarm LEDs
5	Horn
6	Diffusion inlets
7	Contacts for accessories
8	Screw connectors for pump
9	Battery pack (accessible from back)

## Display



Item	Description
1	Alarm Status (backlight) Green - No alarms Orange - Alarm 1 Red - Alarm 2 or 3
2	Clock
3	Flashlight indicator
4	Gases
5	Gas Readings
6	Battery indicator
7	Peak indicator



Key	Description
1	Activate Peak Hold to turn on optional flashlight
2	Reset latching alarm Hold to enter service mode
3	View one gas at a time or STEL/TWA Press to turn on monitor (when off) Hold to turn off monitor (approx 5 sec.)
1 + 3	Rotate the display 180°
2 + 3	Enter calibration mode

## **Battery Installation**

**Batteries must not be replaced in hazardous locations.  
Replace only in non hazardous locations.**

Turn the detector off before you replace the batteries. To replace the batteries or battery pack, unscrew the two screws on the front of the detector and pull the whole pack backwards or insert the allen wrench through one of the screw holes to push the pack backwards.

When the alkaline batteries have to be replaced, use the allen wrench to push the two battery cells out through the PCB holes. When inserting new batteries, check for the correct polarity (see plastic holder). Use only size AA batteries, Duracell MN1500 LR6. Secure the supply module by replacing the two screws.

## Calibration Procedure

Calibration is a two step procedure. The first step is the Fresh Air AutoCal<sup>®</sup> adjustment. In this step the readings of the sensors are automatically adjusted to equal the values expected in fresh air, (20.9% O<sub>2</sub>, 0% LEL combustible gas, and 0 PPM (parts per million) for toxic sensors such as CO and H<sub>2</sub>S).

To perform a Fresh Air AutoCal<sup>®</sup> adjustment:

1. Make sure the instrument is located in a fresh air environment (20.9% oxygen, and no measurable flammable or toxic contaminants)
2. Turn the instrument on and allow the readings to stabilize fully.
3. Attach the calibration adapter to the instrument.
4. The instrument will automatically recognize that the adapter is attached, and display the AutoCal<sup>®</sup> menu screen.
5. Push the "Air" button to initiate the Fresh Air adjustment.
6. The instrument will automatically count down, then begin the adjustment process.
7. The display will list the sensors installed, and show a checkmark by each sensor as the adjustment is completed.
8. After completing the fresh air adjustment the instrument will return to normal operation.
9. Make sure to remove the calibration adapter before using the instrument to detect gas.

The second step in a full calibration is the AutoCal<sup>®</sup> Gas adjustment. In this step the sensitivity of the sensors is automatically adjusted while the sensors are exposed to known concentration calibration gas.

A single cylinder of all-in-one (Quad Mix) calibration gas may be used to automatically calibrate CO, H<sub>2</sub>S and LEL sensors all at the same time.

To initiate AutoCal® Gas calibration using all-in-one (Quad-Mix) calibration gas:

1. Make sure the instrument has been properly Fresh Air adjusted before proceeding to the Gas adjustment.
2. Attach the calibration adapter to the instrument. (If the adapter is already attached, momentarily remove and replace the adapter to display the AutoCal® menu screen.)
3. Turn the regulator on to begin flowing calibration gas to the sensors.
4. You will be prompted to verify that gas has been applied. Press "Yes" to continue.
5. Press "CAL" to make the Gas AutoCal® adjustment.
6. The display will show an hourglass icon by each sensor while it is being adjusted; then a check mark when the adjustment is complete.
7. Make sure to remove the calibration adapter before using the instrument to detect gas.

Sensors may initially fail the Fresh Air or Gas Calibration adjustment. It is usually worthwhile to repeat the failed procedure at least once.

1. Make sure that the sensors (especially the combustible sensor) have had a chance to warm up completely before beginning the Fresh Air or Cal Gas adjustment. Five minutes is usually sufficient.
2. Before making a Fresh Air adjustment, make sure that the calibration adapter and tubing do not contain trapped calibration gas.
3. Make sure the air used for the Fresh Air adjustment does not contain measurable contaminants such as solvent vapors, cigarette smoke or engine exhaust.
4. Make sure that the calibration gas cylinder has not run out of gas.
5. Make sure the calibration gas cylinder, tubing and adapter are properly connected to the instrument.
6. If the sensor still fails calibration, consult the GfG factory for additional advice.
7. Any sensor that fails to calibrate properly must be replaced before using the instrument.

## **Maintenance and Inspection**

Maintenance includes service, calibration and adjustment, as well as repair if it is necessary. Gas monitoring devices can react differently depending on environmental conditions. It is important, independent from maintenance duties, to test the device before putting it into operation each day. Bump testing before each use is highly recommended. The casing can be cleaned with a damp cloth. Never use solvents or detergents!

## Alarms

If the measured gas concentration exceeds a pre-set threshold, the monitor will give audible and visual alarms.

Alarm Type	Sensors	# of alarms	Description
Instantaneous Value (AL)	Oxygen Combustibles Toxic gases	3 3 2	An instantaneous alarm is activated immediately if the gas concentration exceeds or falls below a pre-set threshold. The alarm values are adjustable.
Short Term Value (STEL)	Toxic gases	1	The short-term value (STEL) is the average concentration over a short period of time (e.g. 15 minutes). The STEL alarm is not latching; it resets automatically as soon as the concentration falls below the threshold.
Long Term Value (TWA)	Toxic gases	1	The long-term value (TWA) refers to an 8-hour shift and calculates the average concentration. The TWA alarm cannot be reset. It is only de-activated if the detector is switched off.*

To reset an “over range” CH<sub>4</sub> (LEL) alarm, move the instrument to a clean air environment and press the **RESET** button and answer yes to “Fresh air?” Make sure the atmosphere in the vicinity of the CH<sub>4</sub> sensor is free of contaminants.

\*Note: To avoid possible personal injury, do not turn off the detector during a work shift. TWA, STEL and Max readings are reset when the G450 is turned off

## Service

Service consist of the maintenance, inspection and repair of the gas monitoring device. The function test has to be performed before the first operation and at least once a year and comprises:

- Status of the zeropoint
- Charging status of the battery
- Pump and diffusion inlet
- Display with zero gas and standard test gas and adjustment, if necessary
- Alarm signal release, e.g. with alarm test gas
- Constantly amplified signal with standard test gas
- Response time

Any repair of the G450 must be done according to the manufacturer's instructions and with genuine spare parts.

## Troubleshooting

Symptom	Solution
No power	Check/charge battery
No gas response	Check/replace sensor (see complete user manual)
Alarms in clean (fresh) air	Perform autozero

## Specification

Dimensions: 2.5x4.3x2.0 in (90x140x55 mm)

Weight: 10 oz (280 g) with O<sub>2</sub>/LEL/CO/H<sub>2</sub>S sensors

Climate conditions:

Temperature: -4 to +122°F (-20 to +50°C)

Humidity: 5 to 95% r.h. (non-condensing)

Pressure: 700 to 1300 hPa

Detection Range: Please refer to complete operating manual "Sensor Types and Detection Ranges"

Sensor type: Please refer to complete operating manual "Sensor Types and Detection Ranges"

Alarm Conditions: Alarm 1, alarm 2, alarm 3, TWA, STEL, battery, confidence blip

Vibrating alarm: standard

Audible alarm: 103 dB at 30 cm (1 foot)

Display: Illuminated LCD full graphic display

Visual alarm: Bright, 360° wraparound LEDs plus heterochromatic (green/orange/red) backlight display

Backlight: Automatic when a key is pressed or any alarm condition is activated

Self-test: Initiated upon start up.

Calibration: Manual or automatic.

User options: Location ID, User ID, Confidence blip, audible alarm levels (103 dB, 95 dB, or off), display contrast, time, next inspection date, language selection, adjustable alarm levels, disable vibrating alarm, latching alarm 2, sensor deactivation, security code, combustible sensor (0-100% LEL or 0-5% vol), set span values, autosave and datalogging (mode and interval)

Battery operating time: Up to 24 hours

Approved batteries: GfG NiMH rechargeable battery pack or Duracell MN1500 LR6

Battery charger: GfG cradle or smart cap charger

Charge: up to 4 hours

Warranty: Limited lifetime on instrument and electronics; 3 yrs from date of purchase for O<sub>2</sub>, LEL, CO, and H<sub>2</sub>S sensors.

Approvals: cCSAus 

Approved: Class I, Division 1, Group A, B, C, and D  
Class I, Zone 0: Ex ia IIC T3

Standards: ATEX: II 2G EEx ia d IIC T3/T4  
CSA C22.2 No. 152-M1984  
UL 913  
ANSI / ISA-12.13.01-2000

EMI/RFI resistance: EMC directive 89/336/EEC

## Caution

△ **WARNING** Substituting components may hinder intrinsic safety.

△ **WARNING** For safety reasons, this equipment must be operated and serviced by qualified personnel only. Read and understand the user manual completely before operating or servicing this device.

△ **WARNING** Do not use the detector if it is damaged. Before you use the detector, inspect the case. Look for cracks or missing parts.

△ **WARNING** If the detector is damaged or something is missing, contact GfG Instrumentation, Inc. immediately.

△ **WARNING** Calibrate the detector before first-time use and then on a regular schedule, depending on use and sensor exposure to poisons and contaminants.

△ **WARNING** GfG recommends that you “bump test” the sensors before each use to confirm their ability to respond to gas. To do this, expose the detector to a gas concentration that exceeds the alarm set points. Manually verify that the audible and visual alarms are activated. Calibrate if the readings are not within the specified limits.

△ **WARNING** It is recommended that the combustible sensor be checked with a known concentration of calibration gas after any known exposure to catalyst contaminants/poisons (sulfur compounds, silicon vapors, halogenated compounds, etc).

△ **WARNING** The combustible sensor is factory calibrated to 50% LEL methane. If monitoring a different combustible gas in the % LEL range, calibrate the sensor using the appropriate gas.

△ **WARNING** High off-scale readings may indicate an explosive concentration.

△ **WARNING** Only the combustible gas detection portion of this instrument has been assessed for performance by CSA International.

△ **WARNING** Protect the combustible sensor from exposure to lead compounds, silicones and chlorinated hydrocarbons. Although certain organic vapors (such as leaded gasoline and halogenated hydrocarbons) may temporarily inhibit sensor performance, in most cases the sensor will recover after calibration.

△ **WARNING** For use only in hazardous locations where oxygen concentrations do not exceed 20.9% volume (v/v).

△ **WARNING** Any rapidly increasing reading followed by a declining or erratic reading may indicate a gas concentration beyond the upper scale limit, which may be hazardous.

△ **WARNING** Extended exposure of the G450 to certain concentrations of combustible gases and air may stress detector elements, which can seriously affect the device's performance. If an alarm occurs due to a high concentration of combustible gases, recalibration should be performed, or if needed, the sensor replaced.

△ **WARNING** Do not test the combustible sensor's response with a butane cigarette lighter; doing so can damage the sensor.

△ **WARNING** Do not expose the detector to electrical shock and/or severe continuous mechanical shock.

△ **WARNING** Do not attempt to disassemble, adjust or service the detector unless instructions for that procedure are contained in the manual and/or that part is listed as a replacement part.

△ **WARNING** Electromagnetic interference (EMI) signals may cause incorrect operation of this detector

## Sensor Specifications

### MK376-5 Electrochemical sensor for oxygen O<sub>2</sub>

Response time		t50: <10 sec	t90: <20 sec
Pressure	800...1200 hPa:	max. ±0.2Vol.% or ±2.5% of range	(referred to 1000 hPa)
Humidity	0%...90% r.h.:	max. ±0.2Vol.% or ±2.5% of range	(referred to 50% r.F.)
Temperature	-20...+50°C:	max. ±0.5Vol.% or ±2.5% of display	(referred to 20°C)
Expected lifetime:		3 years in air	

### MK344-5/-6 Electrochemical sensor for carbon monoxide CO

Response time		t50: <15 sec	t90: <45 sec
Pressure	800...1200 hPa:	max. ±3ppm or ±7% of display	(referred to 1000 hPa)
Humidity	15%...90% r.h.:	max. ±3ppm or ±7% of display	(referred to 50% r.F.)
Temperature	-10...+40°C:	max. ±3ppm or ±7% of display	(referred to 20°C)
Temperature	-20...+50°C:	max. ±3ppm or ±15% of display	(referred to 20°C)
Cross sensitivities:		H2S<4%; C2H4<50%; H2<40%; NO<9%; NO2<±5%; SO2=Cl2=C2H6=0% (*1)	
Expected lifetime:		3 years	

**MK429-5/-6 Electrochemical sensor for hydrogen sulfide H<sub>2</sub>S**

Response time		t50: <15 sec	t90: <45 sec
Pressure	800...1200 hPa:	max. ±2ppm or ±10% of display	(referred to 1000 hPa)
Humidity	15%...90% r.h.:	max. ±2ppm or ±10% of display	(referred to 50% r.h.)
Temperature	-10...+40°C:	max. ±2ppm or ±10% of display	(referred to 20°C)
Temperature	-20...+50°C:	max. ±2ppm or ±15% of display	(referred to 20°C)
Cross sensitivities:		SO <sub>2</sub> ≈ 20%; NO <sub>2</sub> <-20%; CO<1%; NO<0,2%; H <sub>2</sub> <0,1%; (*1)	
Expected lifetime:		3 years	

**MK211-6 Catalytic combustion sensor for combustible gases and vapours**

Response time:		t90: <30 sec	
Pressure	950....1100 hPa:	max. ±5% of range or ±15% of display	(referred to 1000 hPa)
Humidity	5%...90% r.h.:	max. ±5% of range or ±15% of display	(referred to 55% r.h.)
Temperature	-20...+ 50°C:	max. ±3% of range or ±10% of display	(referred to 20°C)
Cross sensitivities	2.00Vol.% H <sub>2</sub> : approx.160%;0.70Vol.% C <sub>4</sub> H <sub>10</sub> : approx.7.2%;		
at 50%LEL:	2.20Vol.% CH <sub>4</sub> : 100%;0.70Vol.% C <sub>5</sub> H <sub>12</sub> : approx.7.1%;		
	0.85Vol.% C <sub>3</sub> H <sub>8</sub> : approx.85%;0.50Vol.% C <sub>6</sub> H <sub>14</sub> : approx.55%;		
<i>The above information refers to the detection range for methane. It may vary from sensor to sensor and depends on the gas concentration and on the age of the sensor.</i>			
Expected lifetime:		3 years	

### Accessories and Replacement Parts

Part Number	Description
4002-001	Batteries, alkaline (AA)
4003-450	Battery hardware kit (includes 6 screws and hex key)
1450-202	Battery pack, alkaline (without batteries) with vibrator
1450-211	Battery pack, rechargeable NiMH with vibrator
1450-212	Battery pack, rechargeable NiMH with vibrator and lights
1650231	Cable, data downloading / USB interface (for PC)
7771-450	Calibration adapter with tubing
1450225	Calibration connector
4001-650	Charger, plug-in (110 VAC) wall pack (for use with drop-in charger)
4001-650V	Charger, vehicle
1450001	Oxygen Sensor
1450005	Combustible (LEL)
1450004	Carbon Monoxide (CO)
1450003	Hydrogen Sulfide (H <sub>2</sub> S)

**GfG Instrumentation, Inc.**

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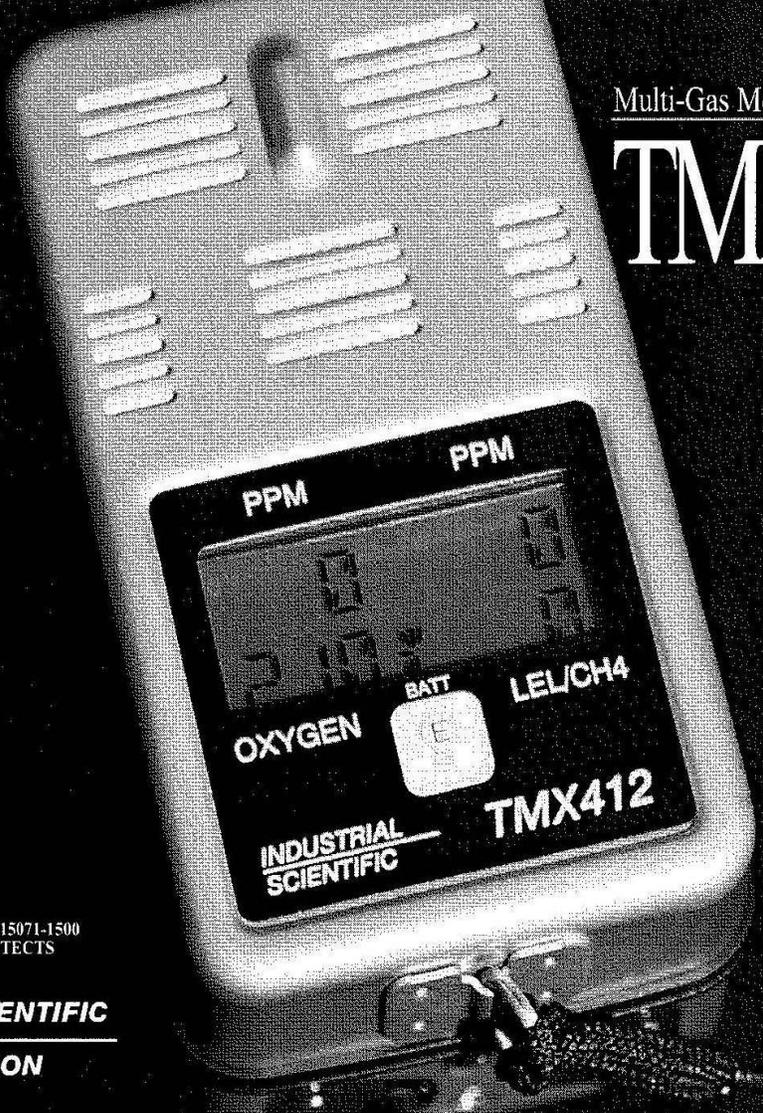
**GfG Instrumentation**

Worldwide Manufacturer of Gas Detection Solutions  
7004-451 Rev. 1 (Jan 09)

P/N 1705-0816  
REV 10 Printed 1000-5000  
Specifications Subject to Change

Multi-Gas Monitor

# TMX 412



**GUARANTEED.**  
**FOR LIFE.**

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FAX 412-788-8353

**INDUSTRIAL SCIENTIFIC**  
**CORPORATION**

Instruction  
Manual



**TABLE OF CONTENTS**

1.	WARNINGS AND CAUTIONARY STATEMENTS	3
2.	UNPACKING THE INSTRUMENT	4
3.	TMX412 FEATURES	4
4.	INSTRUMENT OPERATION	8
4.1	Charging the Battery	8
4.2	Turning the TMX412 On and Off	9
4.3	Display Backlight	9
4.4	TMX412 Operating Modes	9
4.4.1	Reading	9
4.4.2	Sensor Configuration	9
4.4.3	Zero	10
4.4.3	Peak	10
4.4.4	Peak Clear	10
4.4.6	Date	10
4.4.7	Cal Date	10
4.4.8	Log Time	10
4.4.9	TWA	10
4.4.10	STEL	10
4.4.11	Hygiene Reset	10
4.5	TMX412 Alarm Indicators	11
4.5.1	Low Alarm	11
4.5.2	High Alarm	11
4.5.3	Over-Range Indication	11
4.5.4	Combustible Gas Over-Range	11
4.5.5	Low Battery Warning	12
4.5.6	Battery Failure	12
4.5.7	Fault Indication	12
5.	CALIBRATING THE TMX412	12
6.	CHANGING INSTRUMENT SETTINGS	15
6.1	Setpoint	15
6.2	Alarms	16
6.3	Battery	17
6.4	Code	18
7.	HYGIENE FUNCTIONS	18
7.1	Definition of Terms	18
7.1.1	Data Log	18
7.1.2	Period	18
7.1.3	Logging Session	18
7.1.4	Real Time Clock	18
7.1.5	Log Time Clock	18
7.1.6	Calendar	19
7.1.7	TWA	19
7.1.8	STEL	19
7.2	Principles of Operation	19
7.3	Resetting the Hygiene Functions	19
8.	MAINTENANCE	20
8.1	Cleaning	20
8.2	Changing the Battery	20
8.3	Opening the Instrument for Service	21
8.4	Replacing Water Barriers	21
8.5	Installing or Changing Sensors	21
8.5.1	Toxic Sensor Removal	22
8.5.2	Combustible Sensor Removal	22
8.5.3	Oxygen Sensor Removal	22
8.6	Instrument Reassembly After Service	23
9.	REPLACEMENT PARTS	26
10.	SPECIFICATIONS	27
11.	DEFAULT ALARM SETTINGS	28
12.	TMX412 OPTIONS & ORDERING INFORMATION	29
13.	WARRANTY	30

**1. WARNINGS AND CAUTIONARY STATEMENTS**

Failure to observe certain procedures or conditions may impair the performance of the instrument. For maximum safety and performance while using the instrument, please read and understand the procedures and conditions outlined below.

- ▲ Oxygen deficient atmospheres may cause readings of combustible gas lower than actual concentrations.
- ▲ Oxygen enriched atmospheres may cause readings of combustible gas higher than actual concentrations.
- ▲ Verify calibration of the combustible gas sensor after use where the combustible gas content causes the instrument to latch in the OVER-RANGE alarm condition.
- ▲ Silicone compound vapors may cause desensitization of the combustible gas sensor and may cause readings of combustible gas to be lower than actual gas concentrations. If the instrument has been used in an area where silicone vapors were previously present, always verify the instrument's calibration before next use to ensure accurate measurements.
- ▲ Sensor aperture areas and water barriers must be kept clean. Obstruction of the sensor aperture areas and/or contamination of the water barriers may cause readings to be lower than actual gas concentrations.
- ▲ Sudden changes in atmospheric pressure may cause temporary fluctuations in the oxygen reading.
- ▲ Recharge battery only in a non-hazardous location.
- ▲ Use the RS-232 port only in a non-hazardous location.
- ▲ Instrument is tested for intrinsic safety in explosive gas/air (21% oxygen) mixtures only.
- ▲ **CAUTION:** High Over-Range (+OR) combustible gas readings may indicate an explosive concentration of combustible gas.

## 2. UNPACKING THE INSTRUMENT

The shipping box should contain the following items. Account for each item before discarding the box.

QUANTITY	PART NUMBER	DESCRIPTION
1	1810-2183	TMX412 Multi-Gas Monitor
or 1	1810-2434	TMX412 Multi-Gas Monitor (Australian Version)
1	1705-0816	TMX412 Instruction Manual
1	1705-0745	Keypad Overlay
1	1810-1824	Leather Carrying Case
1	1705-2946	Maintenance Tool
or 1	1705-0278	Maintenance Tool (Australian Version)
1	1704-2839	Calibration Cup
1	1704-4157	Teflon Lined Tygon Tubing

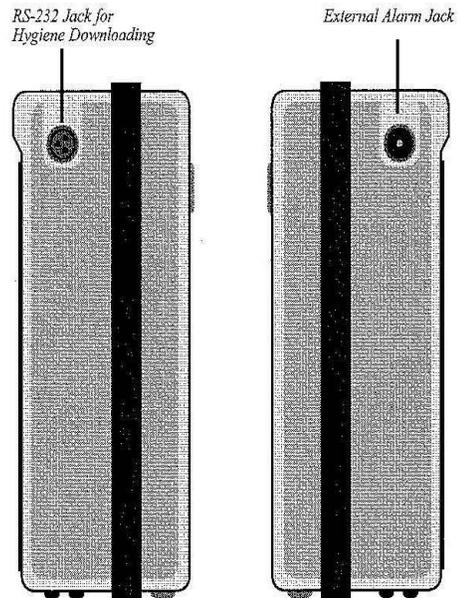
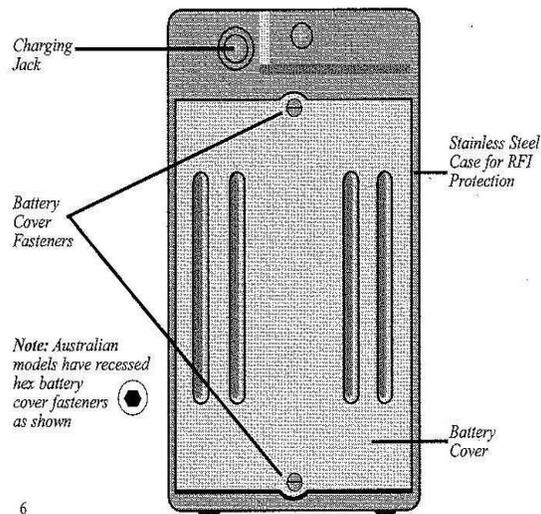
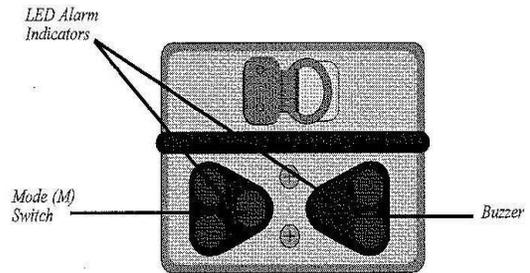
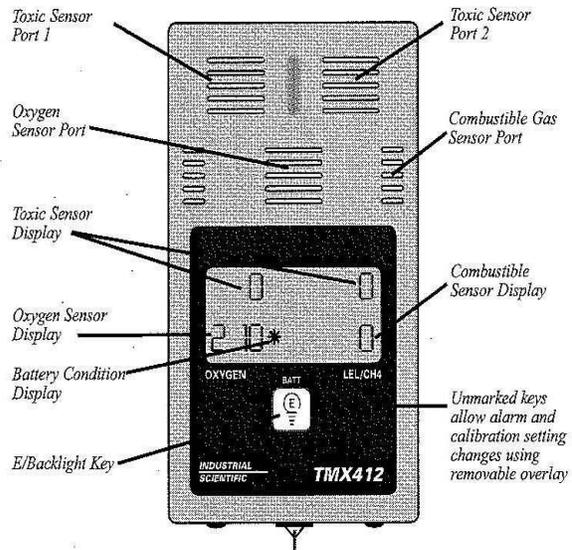
After unpacking, if any listed item is missing, contact either your local distributor of Industrial Scientific products, or call Industrial Scientific Corporation at 1-800-DETECTS (338-3287) in the United States and Canada, or 412-788-4353.

## 3. TMX412 FEATURES

The Industrial Scientific TMX412 Multi-Gas Monitor may be configured to continuously monitor one, two, three or four gases in any combination of the following:

- Oxygen
- Combustible gases (%LEL) or methane (% by volume CH<sub>4</sub>). User selects %LEL or %CH<sub>4</sub> prior to calibration.
- Any two of the following toxic gases:
  - Carbon Monoxide
  - Hydrogen Sulfide
  - Sulfur Dioxide
  - Chlorine
  - Nitrogen Dioxide
  - Chlorine Dioxide

- The TMX412 automatically recognizes and displays the sensor configuration when switched on.
- One-Button microprocessor controlled calibration.
- Illuminated display for viewing in low light conditions.
- Round-the-clock monitoring capability using the interchangeable nickel-cadmium rechargeable, disposable lithium, or disposable alkaline battery packs.
- Plug-in sensors that can be changed or replaced without special tools or soldering equipment.
- Audible and visual alarm indicators.
- Optional external audible or vibrating alarms.
- High and low alarms for combustible and toxic gases; enrichment and depletion alarms for oxygen.
- User selectable access code for security of calibration and alarm settings.
- Combustible gas OVER-RANGE protection.
- PEAK reading mode.
- Press and hold power switch to prevent accidental turn on or turn off.
- Hygiene/Data Log option that can be installed by the factory or the customer, to provide short term exposure limit (STEL) and time-weighted average (TWA) readings with data logging.
- The TMX412 is classified as intrinsically safe by the following agencies:
  - Underwriters laboratories (UL).
  - Canadian Standards Association (CSA). *Canadian Standards Association has assessed only the combustible gas portion of this instrument for performance.*
  - Mine Safety and Health Administration (MSHA).
  - Workcover Authority, NSW, Australia.
  - Department of Mineral Resource, NSW, Australia.



## 4. INSTRUMENT OPERATION

### 4.1 CHARGING THE BATTERY

**⚠ CAUTION:** If the TMX412 is using the nickel-cadmium battery pack, fully charge the battery pack prior to use.

**NOTE:** *The TMX412 must be turned off while charging the battery.*

A single unit compact trickle (10 hour) charger is available for charging the battery in the instrument. In addition to the compact charger, Industrial Scientific offers a full line of chargers with dual rate (4.5 hour) or trickle charging systems in single, dual or four unit configurations. All chargers are capable of charging the battery in or out of the instrument. All dual rate chargers offer the user selectable discharge-before-charge feature to prevent battery memory conditions caused by some repetitive use patterns. Refer to Section 12, Options and Ordering Information, for a complete listing of available chargers.

When charging the battery pack in the instrument, be certain that the instrument is turned off and place it on the battery charger. To charge the battery pack out of the instrument, remove the pack and place it on the charger.

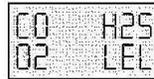
A fully charged battery pack will operate a four-gas configured TMX412 for up to 10 hours. When the instrument is in the normal viewing mode, an eight-segment battery status indicator continuously displays the battery condition. Each segment represents approximately one hour of operating time. When the battery is fully discharged, the display reads BATTERY FAIL and the instrument emits a short beep once a second. Turn off the instrument and recharge the battery pack when BATTERY FAIL appears.

### 4.2 TURNING THE TMX412 ON AND OFF

- Press and hold the MODE switch. The display will read HOLD and the instrument sounds a short beep approximately once a second.
- Continue holding the MODE switch until the RELEASE screen appears. (Stop here if turning the instrument off.)
- After the instrument is turned ON, the following startup screens will be displayed:




SENSOR CONFIGURATION. The type of sensors installed in the instrument will be displayed.



WARM-UP TIMER. The display will indicate the number of seconds remaining until the instrument begins normal operation.

After the warm-up sequence has been completed, the TMX412 will enter the normal operating mode and will be continuously monitoring all calibrated sensors.



### 4.3 DISPLAY BACKLIGHT

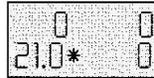
The display backlight is automatically switched on when the TMX412 is in an alarm condition. To manually activate the backlight when needed, press and release the (E) key. The backlight will illuminate the display for approximately 15 seconds.

### 4.4 TMX412 OPERATING MODES

The TMX412 offers different operating modes for accessing various instrument features. To scroll through the operating modes, press and release the MODE switch. The operating modes will be accessed in the following sequence:

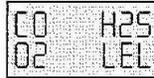
#### 4.4.1 READING

This is the normal operating mode. The current reading of all sensors is displayed along with the graphical battery charge indicator.



#### 4.4.2 SENSOR CONFIGURATION

This mode will display the type of sensor in the position in which it is installed in the instrument.





**4.4.3 ZERO**  
This mode allows the user to zero the instrument and calibrate all installed sensors. Refer to section 5, Calibrating the TMX412, for instruction on the use of the instrument's automatic zero and calibration functions.



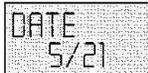
**4.4.4 PEAK**  
This mode will display the highest level of toxic and combustible gas and the lowest level of oxygen measured since the peak readings were last cleared.

• Press the MODE switch to access the PEAK reading screen.



**4.4.5 PEAK CLEAR**  
This mode will clear all stored peak readings from the TMX412. Press enter (E) to clear the peak readings. The display will return to the PEAK mode and indicate that the peak readings have been reset.

If the TMX412 hygiene option is installed in the instrument, the following operating modes may also be accessed. See Section 7, Hygiene Functions, for further instructions.



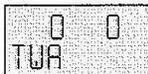
**4.4.6 DATE**  
This screen allows the user to see the current date (month/day) set in the instrument.



**4.4.7 CAL DATE**  
This mode allows the user to see the date the unit was last calibrated.



**4.4.8 LOG TIME**  
This mode allows the user to view the current time set in the instrument (RT) and the length of time that data has been logged in the current session (LT).



**4.4.9 TWA (Time-Weighted Average)**  
This mode displays the current time-weighted average exposure of the toxic sensors installed in the instrument.



**4.4.10 STEL (Short Term Exposure Limit)**  
This mode displays the short term average exposure of the toxic sensors installed in the instrument.



**4.4.11 HYGIENE RESET**  
This mode allows the user to reset the hygiene session and the STEL and TWA exposure values.

10

## 4.5 TMX412 ALARM INDICATORS

### 4.5.1 LOW ALARM

When a monitored gas concentration reaches the low level alarm setpoint, the instrument emits a short beep approximately every 1.2 seconds. The four red alarm LEDs and backlight will flash simultaneously. The displayed value of the alarming gas will flash. If the hygiene option is installed, the TWA alarm will mimic the low alarm indicator and the TWA display value in alarm will flash.

### 4.5.2 HIGH ALARM

When a monitored gas concentration reaches the high alarm level setpoint, the instrument emits a continuous dual tone alarm. As with the low alarm condition, the four red alarm LEDs and backlight will flash simultaneously with the displayed gas value. If the hygiene option is installed, the STEL alarm will mimic the high alarm indicator and the STEL display value in alarm will flash.

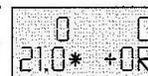
**NOTE:** The TMX412 uses the continuous high alarm tone for both low (depletion) and high (enrichment) oxygen alarm conditions.

### 4.5.3 OVER-RANGE INDICATION

An over-range condition occurs when a sensor reading exceeds the upper limit of the instrument display range. Over-Range is indicated by +OR in the appropriate sensor display location. With the exception of combustible gas over-range, all over-range conditions will clear automatically when the gas concentration has decreased to a level within the display range of the instrument.

### 4.5.4 COMBUSTIBLE GAS OVER-RANGE

When the TMX412 detects combustible gases in excess of 100% of LEL or 5% CH<sub>4</sub> by volume, a high alarm condition is latched and +OR is displayed in place of the combustible gas reading. Power is removed from the combustible gas sensor to prevent damage due to the high level of combustible gas.



11

To clear the combustible gas over-range alarm:

- Exit the hazardous area immediately.
- Press the enter (E) key in clean air.

**NOTE:** *When the enter (E) key is pressed, the combustible gas level must be less than 100% of LEL or 5% CH<sub>4</sub> to clear the combustible gas over-range condition.*

#### 4.5.5 LOW BATTERY WARNING

When approximately 1 hour of instrument operation energy remains in the battery, the instrument emits a short beep every 15 seconds. In addition, the battery indicator will be replaced by a flashing "B" on the display.

**NOTE:** *The length of warning time will increase when there is no combustible gas sensor installed in the instrument.*



#### 4.5.6 BATTERY FAILURE

When the battery has insufficient charge to operate the instrument, "BATTERY FAIL" is displayed. The instrument stops monitoring and emits a short beep once every second.

When "BATTERY FAIL" appears, turn off the instrument immediately. Recharge or replace the battery.

#### 4.5.7 FAULT INDICATION

The TMX412 will emit a short beep approximately once a second if a newly installed sensor does not agree with the valid sensor type for that position when the instrument is turned on. The corresponding display position will be blank. This fault indication occurs when a toxic or combustible sensor becomes disconnected or a combustible fault is detected during normal operation. Sensor types become valid only after a successful calibration has been completed.

## 5. CALIBRATING THE TMX412

The TMX412 is a potential life saving device. Recognizing this fact, Industrial Scientific Corporation recommends that a functional ("bump") test be performed on every instrument prior to each days use. A functional test is defined as a brief exposure of the monitor to a known concentration of gas(es) for the purpose of verifying sensor and alarm operation and is not intended to be a measure of the accuracy of the instrument.

Industrial Scientific further recommends that a full instrument be performed using a certified concentration(s) of calibration gas(es) monthly to ensure maximum accuracy.

If an instrument fails to operate properly following any functional "bump" test, a full instrument calibration should be performed prior to use.

Calibration will be most accurate when the instrument has been in a stable temperature environment for at least one hour prior to calibrating.

**NOTE:** *Instrument zero and oxygen span calibration should be performed in clean air containing 20.95% (21%) oxygen. If you are measuring a known combustible gas, use a known %LEL concentration of that gas for span calibration. For general combustible gas measurement, Industrial Scientific Corporation recommends calibrating to pentane in the 15-50% LEL range. The measured LEL concentration of gases other than the calibration gas may not correspond on a one-to-one basis with the monitor reading. Calibration gas flow rate should be between 0.5 and 1.0 liters per minute. Apply CL<sub>2</sub> at a 1.0 liter per minute flow rate. Always use teflon or teflon lined tubing when calibrating Cl<sub>2</sub> or NO<sub>2</sub> sensors.*

The TMX412 utilizes a one-button calibration system. When using multi-component gas cylinders, a full instrument span calibration can be performed in a single step. Multi-component calibration gas cylinders are available for combustible gas/carbon monoxide/hydrogen sulfide configurations.

To calibrate the TMX412:

- From the normal READING mode, press the MODE switch to access the ZERO operating mode.
- Press the (E) key to start the instrument zeroing process. The instrument display will indicate ZEROING.
- When zeroing is complete the instrument display will indicate O2 CAL and will show the current full span value of the oxygen sensor. The oxygen sensor will be spanned to 21.0 in approximately 30 seconds. Oxygen calibration may be aborted at this time by pressing the MODE switch.

**NOTE:** *Zeroing the instrument in clean air is preferred, provided that there is no trace of toxic or combustible gas that would cause the instrument to respond. If the air purity is uncertain, use a cylinder of zero grade air to zero the instrument and span the oxygen sensor.*



GO CAL  
PRESS

25 LEL  
APPLY



• At the completion of the oxygen sensor span operation the instrument will emit a short beep and the display will indicate GO CAL and the message PRESS (E) to CAL will scroll across the bottom of the display. Press (E) to continue calibrating the remaining sensors. Ignoring this message will result in the instrument returning to the normal operating mode in approximately eight seconds.

• When the GO CAL prompt has been acknowledged, the instrument will display the first sensor to be calibrated along with the span gas value. The message APPLY CAL GAS will scroll across the bottom of the display.

**NOTE:** *APPLY CAL GAS means connect the calibration cup to the appropriate calibration gas cylinder. Place the calibration cup on the instrument as shown. Turn on gas supply.*

• Apply the appropriate concentration of calibration gas. The instrument will wait for three minutes to sense that calibration gas has been applied before aborting and failing calibration. When the instrument senses a concentration greater than 50% of the span gas setting the display will indicate the current full span value for that sensor. The message CAL IN PROCESS will scroll across the bottom of the display.

• When calibration of the sensor has been successfully completed, the instrument will automatically step to the next sensor to be calibrated and the preceding step will be repeated.

• When all sensors have been calibrated successfully the instrument will emit a short beep. The sensor configuration will be shown on the display and sensor identifiers will flash to warn of marginal calibration. Marginal calibration will occur if the sensor full span value is less than 70% of the applied gas concentration. A marginal sensor calibration may be an early warning sign that the sensor will soon need to be replaced.

**NOTE:** *If the sensor full span value is less than 50% of the applied gas value, the sensor will fail calibration and the instrument will immediately return to the real time READING mode. When failed calibration or low sensitivity is indicated, verify that the calibration cylinder has not emptied or that the cylinder expiration date has not passed.*

• After displaying the sensor configuration, the instrument will automatically return to the real time READING mode.

## 6. CHANGING INSTRUMENT SETTINGS

Instrument settings, including alarm values, calibration gas concentrations and security code, may only be accessed and changed during the instrument startup sequence.

A keypad overlay is supplied to reveal the location of the hidden keys used for changing instrument settings. Remove the overlay from the protective backing and place it over the instrument faceplate. The clear portion of the overlay will cling to the display window of the faceplate and may be reused.

To access the instrument menus:

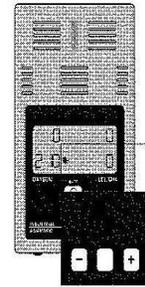
- Turn the TMX412 off and back on again.
- When the display shows the warm up timer, press the plus (+) and minus (-) keys simultaneously.

If the instrument security code has been set to a value other than "0", the CODE screen will be displayed along with the scrolling prompt PRESS (+) OR (-) TO SET (E) TO ENTER. Use the (+) and (-) keys to input the correct security code value and press (E). When the correct code has been entered successfully, the instrument will immediately enter the settings mode.

The settings mode consists of three main functions in the following order:

SETSPAN  
ALARMS  
BATTERY  
CODE

The scrolling prompt, PRESS (+) FOR NEXT (E) TO SELECT appears on each screen. Press the (+) to step through the list and (E) to select any of the main functions. Pressing the MODE switch at any one of the main function headings will cause the instrument to return to the normal operating mode.

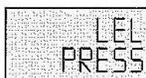


### 6.1 SETSPAN

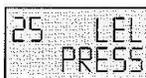
The SETSPAN function allows the user to set the combustible sensor monitoring range to either LEL or CH<sub>4</sub> and to set the calibration gas values for the combustible and toxic sensors.

SETSPAN  
PRESS

- Press (E) to enter the SETSPAN function. The display will show LEL along with the prompt PRESS (+) TO CHANGE.



- Press (+) to toggle between LEL and CH<sub>4</sub> combustible sensor span ranges.



- Press MODE to enter the span gas values for all sensors. The display will show the first span value, eg. 25 LEL, along with the prompt PRESS (+) FOR NEXT (E) TO SELECT.

- Press (E) to select the value you wish to change. The display will flash the current span value and will scroll the prompt PRESS (+) or (-) TO SET (E) TO ENTER.

- Press the (+) and (-) minus keys to set the desired span value and (E) to enter the value into memory. Once the value has been entered into memory, it will become the standard span gas value used during instrument calibration.

- Press the MODE switch to return to the SETSPAN function.

## 6.2 ALARMS

The ALARMS function allows you to set the values for the HI and LOW alarms for each installed sensor. Default alarm settings for each gas are listed in Section 11. If the hygiene/datalogging option is installed, you will also be able to set the STEL and TWA alarm values.



- Press (+) to step from the SETSPAN function to the ALARMS function.



- Press (E) to enter the ALARMS function. The LATCH function will lock the alarm indicators on when a monitored gas concentration reaches the high alarm setpoint. The alarm will reset after the gas concentration has fallen below the alarm setpoint and the user has pressed the (E) key. The display will indicate LATCH along with the scrolling prompt PRESS (+) FOR NEXT (E) TO SELECT.



- Press (E) to select the LATCH function. The display will indicate LATCH along with the prompt PRESS (+) FOR NEXT (E) TO SELECT.



- Press (E) to set the TMX412 high alarm latch as ON or OFF. Press MODE to return to the LATCH screen.



- Press (+) to step to the INSTANT function and set instantaneous alarm values. The display will indicate INSTANT along with the scrolling prompt PRESS (+) FOR NEXT (E) TO SELECT.

- Press (E) to enter the instantaneous alarms function. The display will show the first alarm to be set along with the scrolling prompt PRESS (+) FOR NEXT (E) TO SELECT. The alarm type will be indicated on the display as either high (H) or low (L).



- Press (E) to select the desired alarm to be changed. The display will flash the current alarm value along with the prompt PRESS (+) OR (-) TO SET (E) TO SELECT.

- Press the (+) and (-) keys to set the desired alarm value and (E) to enter the value into memory.

- Press MODE to return to the INSTANT function.

- Press (+) to step to the TWA and STEL alarm functions. The TWA and STEL alarm values are set as previously described.

## 6.3 BATTERY

The BATTERY option allows the user to select the type of battery installed in the unit. The setting configures the battery indicator to accurately display the discharge rate of the selected battery type.

Change the battery setting as follows:

1. From Setup, access the BATTERY option by pressing the hidden + key until "BATTERY" appears on the display and then press the E key.
2. Press the hidden + key to toggle between battery types. The display will show "NCD/LI" for Ni-Cad or lithium batteries and "ALKALNE" for alkaline batteries.
3. Press the E key to select battery type shown.
4. Press the Mode key twice to return to Reading Mode for normal operation of the instrument.



## 6.4 CODE

The CODE function allows the user to select a security code to protect calibration and all instrument alarm settings. When the code is set to any value other than "0", the user will be prompted to enter the proper code prior to entering the settings or calibration modes.



- Press (+) to step from the ALARMS function to the CODE function.
- Press (E) to enter the code function. The display will show the current code setting along with the scrolling prompt PRESS (+) OR (-) TO SET (E) TO ENTER.
- Press the (+) and (-) keys to set the code to any value between 0 and 999, and (E) to enter the value into memory.
- Press MODE to return to the CODE function.



## 7. HYGIENE FUNCTIONS

### 7.1 DEFINITION OF TERMS

#### 7.1.1 DATA LOG

Record of measured gas concentrations, including time and date, stored in the instruments electronic memory.

#### 7.1.2 PERIOD

The logging time that begins when the instrument is turned on and begins normal operation and lasting until the instrument is turned off.

#### 7.1.3 LOGGING SESSION

One or more periods of normal instrument operation between hygiene function resets.

#### 7.1.4 REAL TIME CLOCK

A clock function in the instrument that maintains the current time.

#### 7.1.5 LOG TIME CLOCK

A clock function in the instrument that monitors the length of time logged during a session.

### 7.1.6 CALENDAR

A part of the real time clock function that maintains the current date.

### 7.1.7 TWA (TIME-WEIGHTED AVERAGE)

The accumulated gas exposure averaged over a predetermined time, typically eight hours.

### 7.1.8 STEL (SHORT TERM EXPOSURE LIMIT)

The accumulated gas exposure value averaged for the proceeding fifteen minutes.

## 7.2 PRINCIPLES OF OPERATION

If the TMX412 is equipped with the hygiene option, all instantaneous readings of valid installed sensors are sent to the hygiene module. Once every minute, the readings are averaged, the average values are saved to the data log and the TWA and STEL values are calculated for the toxic sensors. The TWA and STEL values are then tested for possible alarm conditions.

The default time base for calculating TWA values is eight hours. However, the time base may be changed to any integer value in the range of one to 40 hours using the optional TMX Hygiene Software and a personal computer.

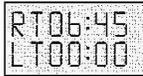
The 130,816 byte memory provides storage capacity for approximately 110 hours of logged data with four sensors installed. The data logging section of the instrument is always powered and a battery backup circuit protects from loss of data for up to 40 minutes during battery changes.

**NOTE:** *The instrument must be stored on a battery charger when not in use to prevent loss of data due to battery discharge.*

## 7.3 RESETTING THE HYGIENE FUNCTIONS

**NOTE:** *If the data logging feature is to be used, ensure the correct date and time information is logged by checking/setting the Real Time Clock and Calendar using the optional TMX Hygiene Software.*

- Press MODE repeatedly to step to the HYGIENE screen.
- Press (E) to reset the hygiene function and begin a new data logging session.



The instrument display will return to the LOG TIME mode and the display will indicate that the log time (LT) will be reset to 00:00. The TWA and STEL values for all toxic sensors will also be reset to zero.



If there is insufficient memory to log approximately 12 hours of data when the hygiene function is reset, the real time clock value will be displayed as RTOR:OR.

When the data memory is full, both the real time and log time will be displayed as OR:OR.



The data memory may be cleared when full by performing a hygiene reset as described above. All currently stored data will be overwritten. The stored data may be downloaded using the TMX hygiene software.

## 8. MAINTENANCE

### 8.1 CLEANING

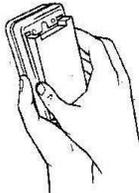
Wipe the outside of the instrument with a soft, clean cloth. Never use solvents or cleaning solutions of any type.



### 8.2 CHANGING THE BATTERY

To change the TMX412 battery pack:

- Hold the instrument with battery cover facing up.
- Turn the battery cover latches counter-clockwise one quarter of a turn using the maintenance tool supplied to release the cover.
- Gently press down on the bottom of the battery pack to release the top contacts.
- Grasp the battery along the edges and lift out.
- Insert replacement battery, and replace battery cover.
- Turn the latches one quarter turn in the clockwise direction to secure the battery cover.



20

**WARNING:** When changing lithium battery cells, replace the cells within the lithium battery pack in a non-hazardous location. Replace the lithium cells with three Duracel DL123A or three Panasonic CR123A or three Sanyo CR123A 3.0 volt lithium battery cells only. Use of another battery may present a risk of fire or explosion.

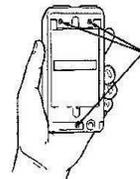
**WARNING:** Lithium battery cells may explode if mistreated. Do not recharge, disassemble, or dispose of in fire. Do not charge the replaceable lithium battery pack either while it is installed in, or removed from the instrument.

**WARNING:** The 1704-9889 replaceable lithium battery pack is not approved for use in applications or areas requiring MSHA approval.

**WARNING:** Australian TMX412, p/n 1810-2434, is to be used with Nicad battery pack p/n 1705-4735 only.

### 8.3 OPENING THE INSTRUMENT FOR SERVICE

- Remove the battery cover and battery.
- Remove the three screws that hold the instrument case halves together.
- Grasp the bottom half of the instrument with one hand. Using the other hand, lift the top until it clears the sensors. Then place it face down next to the instrument. Use care not to damage the flex cable connecting the case top to the main circuit board.

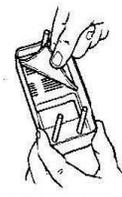


### 8.4 REPLACING WATER BARRIERS

When the sensor water barrier becomes clogged or damaged, it is necessary to replace them.

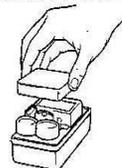
To replace the water barrier:

- Lift the water barrier and filter screen from inside the top case half and remove.
- Place the new water barrier and filter screen in the top case half.



### 8.5 INSTALLING OR CHANGING SENSORS

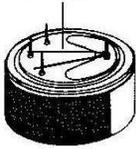
- Open the instrument as described.
- Carefully remove the sensor shroud by lifting it straight up.



21

**NOTE:** The TMX412 must be calibrated whenever a sensor is installed or replaced. All installed sensor types are shown on the Sensor Configuration screen during instrument start-up. However, a fault condition will be indicated if the instrument has not been calibrated for any of the installed sensor types. When a new oxygen sensor is installed, allow 15 minutes for it to stabilize before attempting calibration. If the toxic sensor is replaced with a different type or the combustible sensor is reconfigured, the alarm settings must be changed to reflect the appropriate alarm settings for the sensor installed.

Shorting Wire



### 8.5.1 TOXIC SENSOR REMOVAL/REPLACEMENT

- To remove the toxic sensor, grasp the sensor and lift it straight up. Use care to avoid bending the sensor pins.

**WARNING:** When removing the toxic sensor for storage, connect a shorting wire to the two pins as shown.

- New sensors are shipped with a shorting wire attached. Remove the shorting wire from the new sensor.
- Immediately install the sensor in the instrument. Never apply pressure to the area inside of the black O-Ring seal at the top of the sensor.



### 8.5.2 COMBUSTIBLE SENSOR REMOVAL/REPLACEMENT

- To remove the combustible sensor, grasp the sensor and lift it straight up.
- When installing the combustible sensor, align the notch on the sensor body with the polarizing pin on the sensor board.



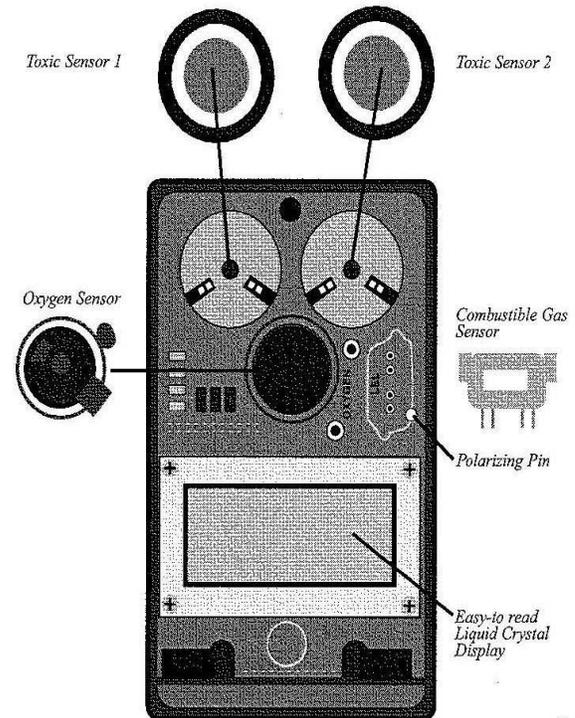
### 8.5.3 OXYGEN SENSOR REMOVAL/REPLACEMENT

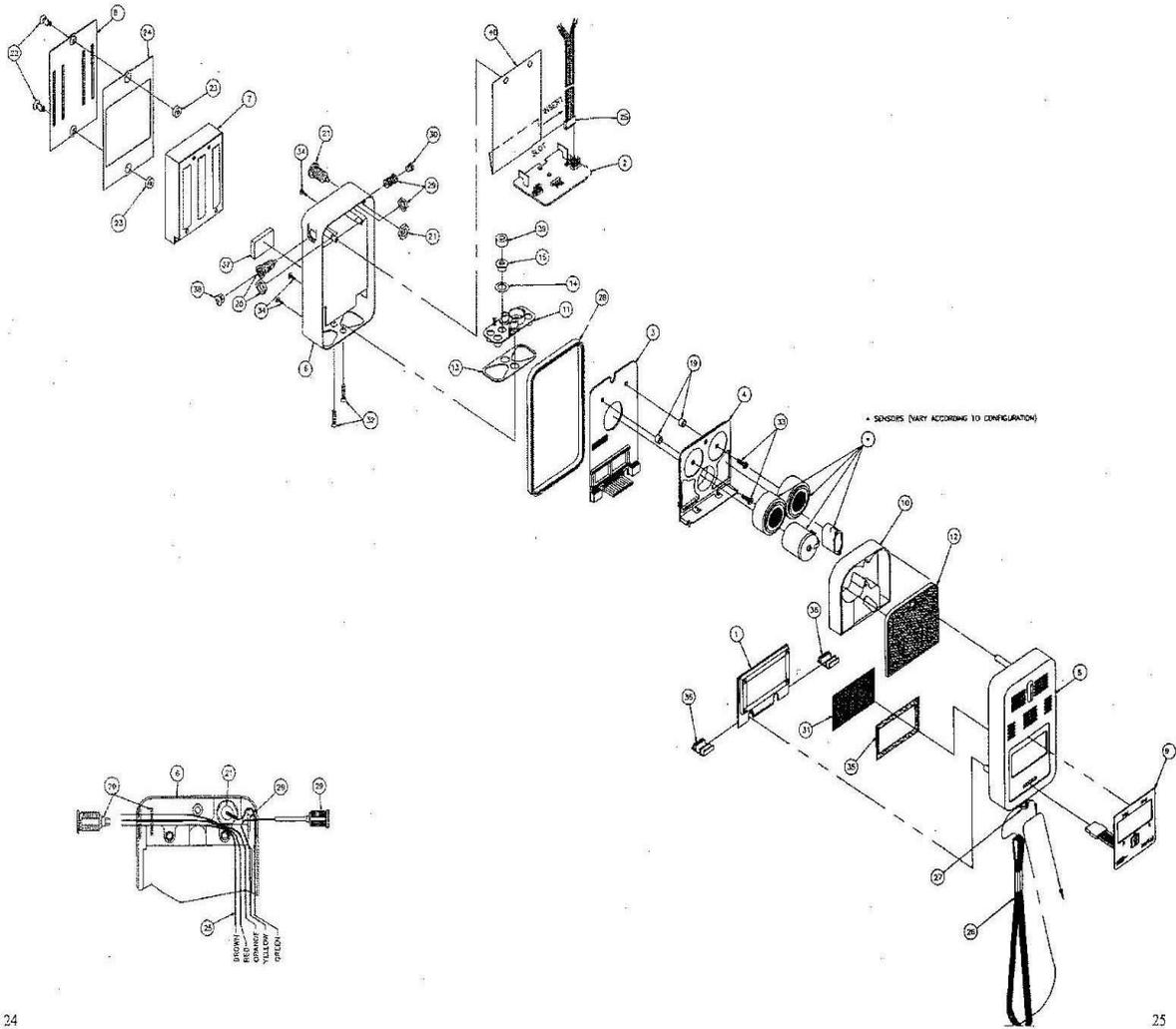
- Remove the two mounting screws and nylon washers using the maintenance tool or small Phillips screwdriver.
- Bend the two mounting tabs out as shown before installing the new sensor.



## 8.6 INSTRUMENT REASSEMBLY AFTER SERVICE

- Reassemble the instrument by aligning the two posts with the corresponding openings in the circuit board. Gently fit the instrument case halves together, making certain that the gasket is properly seated, and the flex cable is not pinched between the buzzer and the instrument case top.
- Replace and tighten the three retaining screws until they are firmly seated. Do not overtighten.
- Replace the battery and battery cover.





## 9. REPLACEMENT PARTS

The following items numbers refer to the exploded view drawing on pages 24 and 25.

ITEM	PART NUMBER	DESCRIPTION (QTY)
1	1704-2680	Display P.C. Board Assembly (1)
or	1705-4222	Display P.C. Board Assembly (1) <i>(Australian Version Only)</i>
2	1705-0660	Alarm P.C. Board Assembly (1)
or	1705-4214	Alarm P.C. Board Assembly (1) <i>(Australian Version Only)</i>
3	1705-0759	Main P.C. Board Assembly (1)
4	1705-0857	Sensor P.C. Board Assembly (1)
5	1705-0753	Case Top Assembly (1)
6	1703-8654	Case Bottom Assembly (1)
7	1704-1872	Nicad Battery Pack (1)
or	1705-4735	Nicad Battery Pack (1) <i>(Australian Version Only)</i>
8	1703-7169	Battery Case Cover (1)
9	1705-0661	Keypad/Faceplate (1)
10	1703-6930	Sensor Shroud (1)
11	1703-7045	Alarm Bezel (1)
12		Sensor Barrier/Seal (1), consists of:
	1705-0479	Sensor Membrane
	1707-8635	Sensor Gasket
13	1703-8118	Alarm Bezel Gasket (1)
14	1703-8746	Mode Button Seal (1)
15	1704-8927	Mode Button (1)
19	1703-7235	Circuit Board Spacer (2)
20	1703-8134	Receptacle, 3 Contact (1)
21	1704-2151	Charging Jack (1)
22	1703-9660	Dzus Stud (2)
or	1705-2827	Dzus Stud (2) <i>(Australian Version Only)</i>
23	1704-2722	Stud Seal (2)
24	1704-4017	Battery Cover Gasket (1)
25	1704-1823	5 Conductor Cable (1)
26	1704-9876	Instrument Strap (1)
27	1704-7994	Split D-Ring (1)
28	1703-1782	RFI Case Gasket (1)
29	1702-8374	External Alarm Jack (1)
30	1702-9273	Hole plug (1)
31	1705-0295	RFI Screen (1)
32	1704-4249	Screw, FHCR 4-40 x .47 SST (2)
33	1703-3689	Screw, PHCR 4-40 x .25 SST (2)
34	1704-2219	Screw, FHCR 4-40 x .38 SST (3)
35	1704-9736	Conductive Tape, RF Screen (1)
36	1705-0776	Circuit Board Support (2)
37	1704-3308	Battery Spacer (1)
38	1704-4066	Data Port Plug (1)
39	1704-6764	Mode Switch Spacer
40	1704-9685	Main Board Insulator

## 10. SPECIFICATIONS

<b>CASE:</b>	Stainless Steel
<b>DIMENSIONS:</b>	4.75" L x 2.75" W x 2" H (121 X 70 X 51 mm)
<b>WEIGHT:</b>	26 ounces (738 grams)
<b>SENSORS:</b>	Combustible Gases and Methane-Catalytic Oxygen and Toxic Gases-Electrochemical
<b>MEASURING RANGE:</b>	LEL (Combustible Gases) 0 to 100% in 1% increments
	CH <sub>4</sub> (Methane) 0 to 5% of volume in 0.1% increments
	O <sub>2</sub> (Oxygen) 0 to 30% of volume in 0.1% increments
	CO (Carbon Monoxide) 0 to 999 PPM (parts per million) in 1 PPM increments
	H <sub>2</sub> S (Hydrogen Sulfide) 0 to 999 PPM (parts per million) in 1 PPM increments
	SO <sub>2</sub> (Sulfur Dioxide) 0.2 to 99.9 PPM (parts per million) in 0.1 PPM increments
	NO <sub>2</sub> (Nitrogen Dioxide) 0.2 to 99.9 PPM (parts per million) in 0.1 PPM increments
	Cl <sub>2</sub> (Chlorine) 0.2 to 99.9 PPM (parts per million) in 0.1 PPM increments
	ClO <sub>2</sub> (Chlorine Dioxide) 0 to 99.9 PPM (parts per million) in 0.1 PPM increments
<b>POWER SOURCE:</b>	Rechargeable, replaceable nickel-cadmium battery pack, replaceable cell lithium battery pack or 9-volt alkaline battery packs
<b>BATTERY LIFE:</b>	With Combustible Sensor 10 hours (Nicad) Without Combustible Sensor 10 days (Nicad)
<b>READOUT:</b>	Alpha-Numeric Liquid Crystal Display
<b>TEMPERATURE RANGE:</b>	Continuous Operation — -20°C to 50°C (-4°F to 122°F)

Intermittent Operation (Up to 8 hours) —

Carbon Monoxide	-20°C to 55°C (-4°F to 131°F)
Chlorine	-20°C to 55°C (-4°F to 131°F)
Hydrogen Sulfide	-40°C to 50°C (-40°F to 122°F)
Nitrogen Dioxide	-20°C to 55°C (-4°F to 131°F)
Oxygen	-20°C to 55°C (-4°F to 131°F)
Sulfur Dioxide	-20°C to 55°C (-4°F to 131°F)
Chlorine Dioxide	-20°C to 50°C (-4°F to 122°F)

**HUMIDITY RANGE:** 15% to 90% RH (Continuous Operation)  
(Non Condensing) 0% to 99% RH (Intermittent Operation)

**STORAGE TEMPERATURE:** 0°C to 20°C (32°F to 68°F)

## II. DEFAULT ALARM SETTINGS

GAS	LOW ALARM	HIGH ALARM
O <sub>2</sub>	19.5%	23.5%
LEL	10%	20%
CH <sub>4</sub>	1.0%	1.5%
CO	35 PPM	70 PPM
H <sub>2</sub> S	10 PPM	20 PPM
SO <sub>2</sub>	2.0 PPM	4.0 PPM
NO <sub>2</sub>	3.0 PPM	6.0 PPM
Cl <sub>2</sub>	0.5 PPM	1.0 PPM
ClO <sub>2</sub>	0.3 PPM	1.0 PPM

## 12. TMX412 OPTIONS & ORDERING INFORMATION

PART NUMBER	DESCRIPTION (QTY)
1704-1856	Combustible Sensor
1702-3516	Oxygen Sensor
1704-1898	Hydrogen Sulfide Sensor
1704-1880	Carbon Monoxide Sensor
1707-3271	Chlorine Sensor
1704-1922	Nitrogen Dioxide Sensor
1704-1906	Sulfur Dioxide Sensor
1706-7174	Replaceable 9-volt Alkaline Battery Pack (includes 2)
1810-2252	115 VAC Compact Economy Charger
1810-2251	115 VAC Two Unit Compact Charger
1810-2558	115 VAC Two Unit Dual Rate Charger
1810-2255	115 VAC Four Unit Dual Rate Charger
1810-2517	230 VAC Four Unit Dual Rate Charger
1810-2566	230 VAC Four Unit Dual Rate Charger
1810-2756	230 VAC Two Unit Compact Charger (Australian Version)
1810-2231	230 VAC Two Unit Compact Charger
1810-1972	230 VAC One Unit Dual Rate Charger
1810-2145	12 VDC One Unit Compact Charger
1810-1915	12 VDC Two Unit Dual Rate Charger
1810-2156	SP402 Sampling Pump with hose (UL)
1810-2169*	SP402 Sampling Pump with hose (CSA)
1810-2285	Constant Flow Hand Pump with Hose
1810-1386	Stainless Steel Extendible Probe - 6ft.
1810-1428	Polycarbonate Probe
1704-1872	Rechargeable Nicad Battery Pack
1704-4735	Rechargeable Nicad Battery Pack (Australian Version)
1707-4204	Chlorine Dioxide Sensor
1704-9889	Replaceable Lithium Battery Pack (includes 3)
1704-7747	Replacement Lithium Battery Cell
1810-1824	Leather Carrying Case for TMX412
1810-2161	Leather Combination Carrying Case for SP402/TMX412
1810-2177	Leather Handle for 1810-2161 Carrying Case
1810-4240	Nylon Carrying Case for TMX412
1810-4109	Nylon Combination Carrying Case for TMX412/SP402
1810-3747	External Audible/Visual Alarm (103 db)
1810-2146*	Vibrating Alarm
1810-2187	Cylinder Cal. Gas, H <sub>2</sub> S, CO, Pentane, Oxygen
1810-1576	Cylinder, Cal. Gas, Carbon Monoxide, Pentane and Oxygen
1810-2165	Cylinder, Cal. Gas, Carbon Monoxide, Methane and Oxygen
1810-1584	Cylinder, Cal. Gas, Zero Air
1810-2222	Cylinder, Cal. Gas, 5 PPM Sulfur Dioxide
1810-1758	Cylinder, Cal. Gas, 10 PPM Chlorine
1810-2219	Cylinder, Cal. Gas, 5 PPM Nitrogen Dioxide
1810-1766	Flow Regulator with Pressure Gauge, for all cylinders except Ammonia
1704-4157	Teflon Lined Tygon Tubing (24")
1704-2839	Calibration Cup

\* Denotes CSA approved accessory

23

## **13. WARRANTY**

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Industrial Scientific portable gas monitoring instruments are warranted to be free from defects in material and workmanship for as long as the instrument is in service.

The above warranty does not include sensors, battery packs, internal pumps or filters, all of which are warranted to be free from defects in material and workmanship for eighteen months from the date of shipment, or one year from the date of first use, whichever occurs first, except where otherwise stated in writing in Industrial Scientific literature accompanying the product.

All other Industrial Scientific products are warranted to be free from defects in material and workmanship for a period of eighteen (18) months from the date of shipment, or one (1) year from the date of first use, whichever occurs first, except where otherwise stated in writing in Industrial Scientific literature accompanying the product.

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